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CANADIAN ELECTRONICS ENGINEERING

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Successful management stimulates professional growth ... 24

Aluminum welding with low temperature fluxless solder ... 26

Latest recording techniques improve quality, frequency range 30

New machine for "Teflon" extrusion 39

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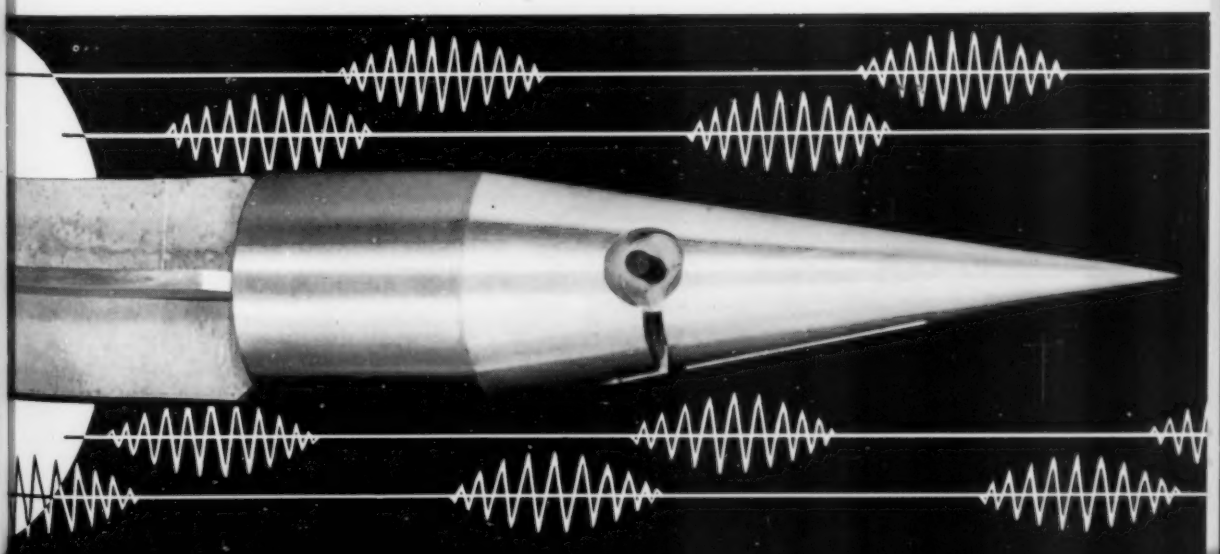

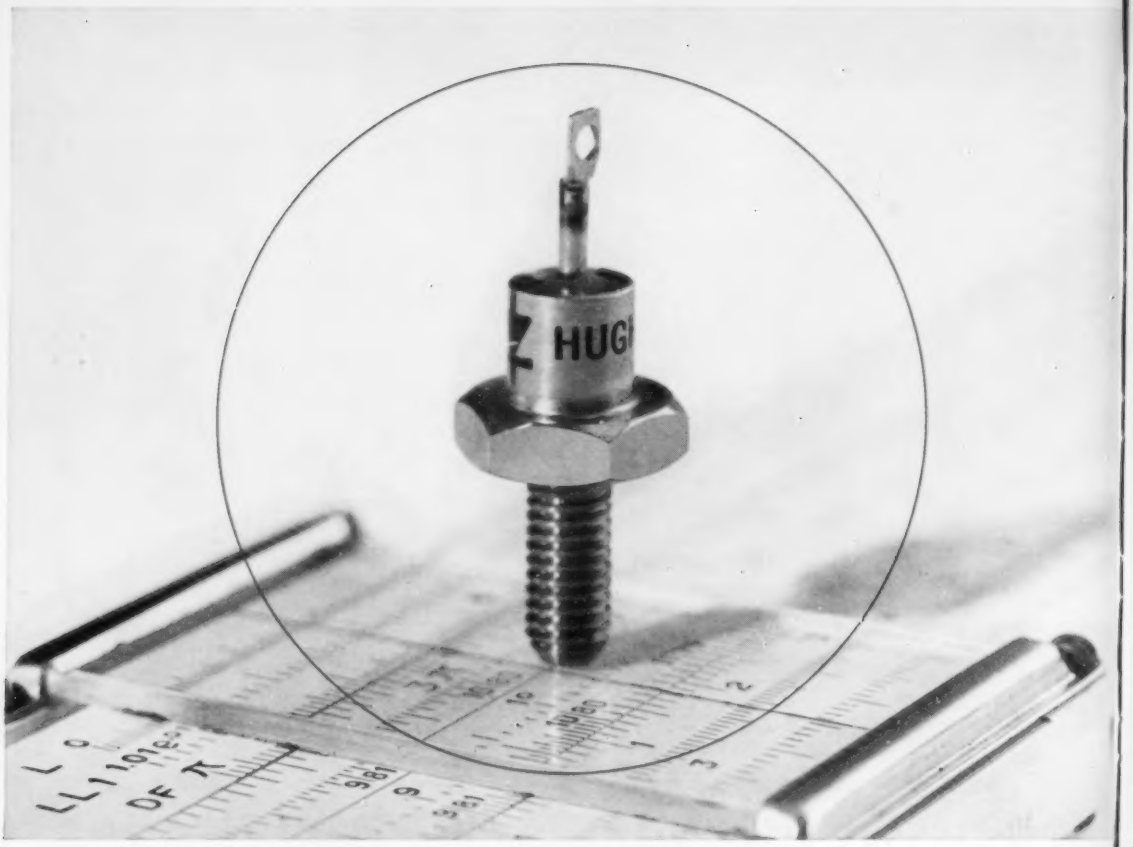

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december 1957

CANADIAN ELECTRONICS ENGINEERING

volume one, number

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***our cover design** *Miniature missile at 2,000 mph sends out position information during its half second flight between antennas*

Another reason why YOUR BEST BUY IS ...

by D. Roddy, Chief Telecommunications Engineer, Pye Canada Limited

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CANADIAN ELECTRONICS ENGINEERING

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contributors and special articles in this issue:

Steel

Duff

Humeniuk

Up to his retirement this year Lieut-Col. **W. Arthur Steel** (Tacan gives pilot continuous indication of aircraft position) had been for many years with Standard Telephones and Cables Mfg. Co. (Canada) Ltd. in Montreal.

He received his BASc from Toronto University in 1915 and during the First World War was Officer-in-charge of Radio Communication for the Canadian Corps in France. Afterward he became Chief Technical Officer for the Royal Canadian Corps of Signals, Department of National Defence, Ottawa, a position he held until 1930.

From 1930 to 32 he was with the National Research Council then went to the Canadian Radio Broadcasting Commission as one of the three commissioners, taking charge of all technical operations.

Col. Steel is a Fellow, and Life Member, of the Institute of Radio Engineers and a Senior Member of the Society of Motion Picture and Television Engineers.

Only eighteen months ago **David L. A. Duff** (Rugged ballistic range telemetry system speeds up data recording) left the University of Toronto with a BASc in electrical engineering.

He went to the Air Armament Department of Canadian Westinghouse and from the beginning was connected with missile work. He worked on missile flight trials in Quebec and since then has been on the development of the ballistic range telemetry system. Some time was also spent in a missile system study in the Westinghouse analogue computation centre.

He is a member of the Association of Professional Engineers of Ontario and of the Institute of Radio Engineers.

Hamilton-born **Peter Humeniuk** (Successful management stimulates professional growth), graduated from the University of Toronto in 1943 in electrical engineering.

He worked at Defence Industries Ltd., Ford Motor Co., Research Enterprises and the U of T before joining Canadian General Electric in 1944 as a radio engineer.

From 1948 to 1950 he was in charge of TV engineering with Rogers Majestic then went back to CGE as Division Engineer of Radio and TV. He was made Manager of Engineering and Manufacturing—Radio and TV in 1952 and in 1955 Manager, Radio and TV plant operation.

He is a Senior Member of the IRE, member of the APEO and is also chairman of the Engineering Education Committee of the Engineering Alumni Association of the University of Toronto.

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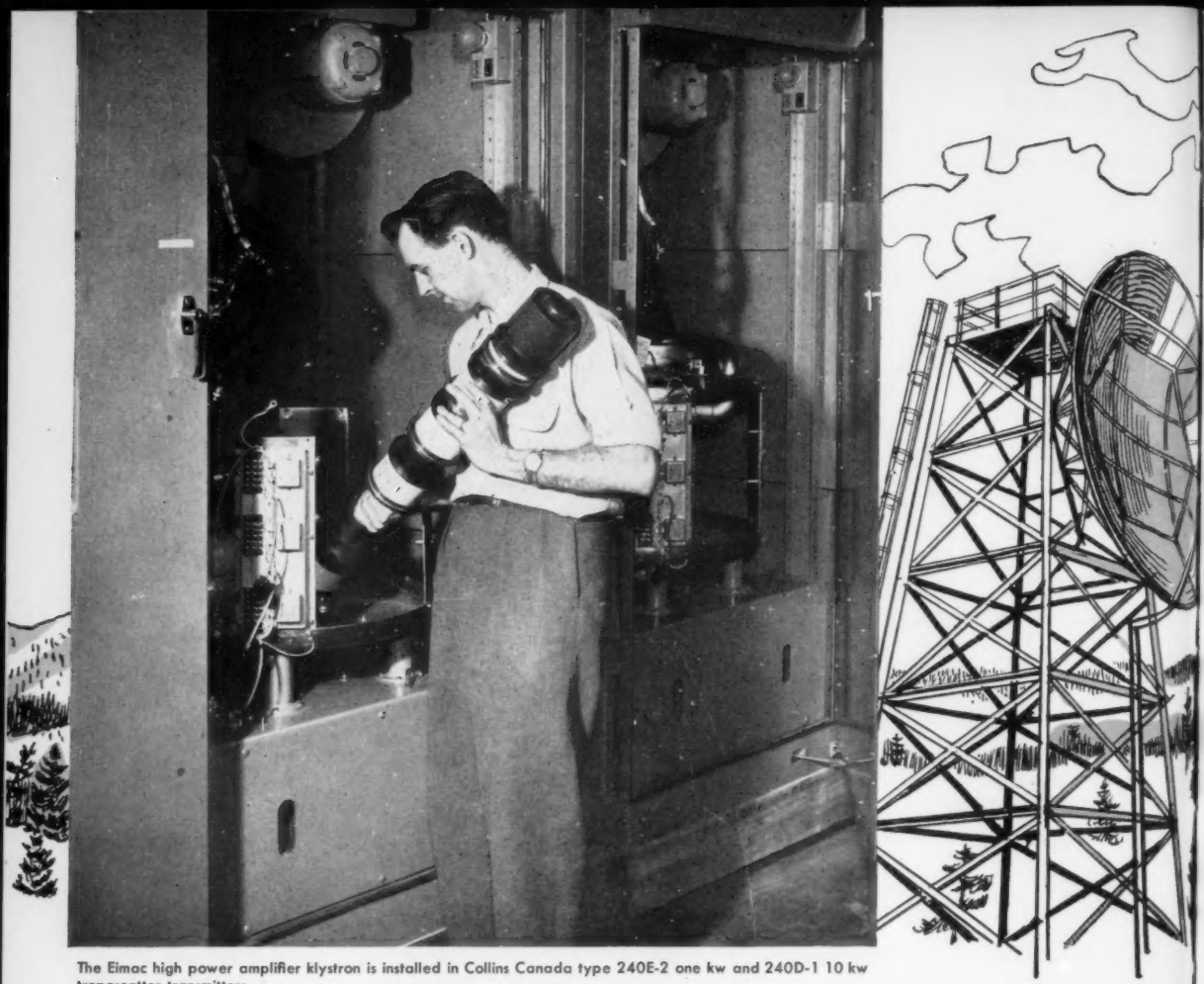

The Eimac high power amplifier klystron is installed in Collins Canada type 240E-2 one kw and 240D-1 10 kw troposcatter transmitters.

Collins Canada

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Canada with its rough, often impassable terrain, provided the need for a modern, reliable long distance communication system. It is here that such a system—a tropospheric scatter communication network was first installed.

Collins was a leading contributor to this network with one kw and 10 kw transmitters.

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RCA Victor step up defence division for CF-105

RCA Victor are taking on new engineers and making a number of appointments in their defence electronic division. Reason is that they expect to do most of the electronics work on the CF-105 under subcontract from the American RCA.

In one of three new appointments made by RCA Victor R. J. Good becomes manager, Defence Electronic Systems Engineering. An MSc, University of Toronto, he has been with RCA Victor for seven years and has been doing development work on the CF-105 equipment.

E. W. J. Morris is appointed manager, contracts administration, Defence Electronic Systems Engineering. He has been responsible for the administration of all RCAF and microwave projects.

Good

Morris

D. R. Sherwin is now manager, operations and engineering, Defence Electronic Systems Engineering. A BSc, London University, and a graduate of the College of Aeronautical Engineering, London, he has had technical experience ranging from aircraft structural design to process development on gas turbines. He came to RCA Victor four years ago as manager, Mechanical Engineering Design and Development.

Moves to post of General Manager

Syntron (Canada) Limited, Stoney Creek, Ontario, manufacturers of electromagnetic vibratory equipment, have appointed William B. Armstrong to the position of general manager.

His previous position was that of Western district manager and general sales co-ordinator, a post he had filled since 1956. He began with Syntron in 1954.

Mr. Armstrong, a member of the Canadian Industrial Management Association was born in Toronto and studied at Humberside Collegiate Institute and the University of Toronto.

Sherwin

Armstrong

First Canadian to be an F.M.S.

Dr. Peter M. Millman, head of the upper atmosphere research section, Radio and Electrical Engineering Division, National Research Council of Canada, has been elected a Fellow of the Meteoritical Society.

This international organization, affiliated with the American Association for the Advancement of Science, was formerly known as the Society for Research on Meteorites.

Dr. Millman is the first Canadian to be made a Fellow of this Society.

New representative for Eimac

Eitel-McCullough Inc., San Bruno, California, manufacturer of Eimac electron-power tubes, have appointed R. D. B. (Ben) Sheppard, P.Eng., as their new Canadian field representative. His offices are at 2036 Prince Charles Road, Ottawa 3, Ontario.

Mr. Sheppard has handled the Eimac product line for one and a half years during previous associations. He has served with the engineering department of the Canadian National Telegraphs and for two years was assistant general radio engineer.

He is a graduate of the University of Toronto and a member of the Institute of Radio Engineers.

Application laboratory for industry use

Product manager of Philips Industries high frequency induction heating equipment is now Gary W. Matheus, P.Eng. He comes under the Scientific and Industrial Apparatus Division.

Mr. Matheus will also be in charge of Philips Application Laboratory, the facilities of which are available to industry for the study of the application of induction heating to brazing, hardening, annealing, forging and melting.

Matheus

Cotton

Group Captain joins Aviation Electric

Group Captain C. H. Cotton has been made special assistant to the president of Aviation Electric Ltd., of Montreal.

G/C Cotton recently retired from the RCAF where he held the position of acting chief of Aeronautical Engineering. In his new position he is located in Ottawa and his primary duty is to serve as liaison between Aviation Electric Ltd. and customers located in that area.

Decca expand their radar division

Canadian-born J. W. Paddon has been appointed manager of the radar systems division of Decca Radar (Canada) Ltd.

His radar experience began at the Royal Aircraft Establishment in 1939. In World War II he was stationed in Washington by the Department of Munitions and Supply and returned there during the Korean crisis as chief of the Electronics Division of the Department of Defence Production.

Prior to his new appointment Mr. Paddon was supervisor of administration in Canadair's special weapons division.

A. P. E. O. registrations increase

The Association of Professional Engineers of Ontario announces there are 16,094 registered members, an increase of 1,317 over 1956.

The engineering technician program has been revised to classify the first two grades as engineering technologists (grades I and II) and the remaining three grades as engineering technicians. So far 419 applications have been received for certification as technicians and technologists.

Here and there

Cannon Electric Canada Limited have made Marty Howard, 132 Crocus Ave., Ottawa, Ontario, their sales representative in the Ottawa area and Eastern Ontario.

D. S. Grant has been appointed general works manager of Canada Wire and Cable Company Limited, Toronto. He succeeds F. A. Pankhurst who resigned for health reasons.

Be sure to advertise in the . . .

REVIEW & FORECAST number of . . .

CANADIAN ELECTRONICS ENGINEERING

Published in January 1958

In January, 1958, Canadian Electronics Engineering will publish its first annual REVIEW & FORECAST of Canada's electronics industry. Well-illustrated by photos, charts and tables — this will be the most comprehensive report on the industry ever made to Canadians engaged in electronics and its allied fields.

The Annual REVIEW & FORECAST will feature new equipment, contracts received and contracts completed, and report on all significant increases in volume and areas of activity.

Packed with authoritative information on past, present and future electronic development, this January issue of Canadian Electronics Engineering will be awaited with more than usual interest by all our readers . . . the people in Canadian industry who buy and specify electronic equipment.

The importance of the Annual REVIEW & FORECAST and the assured interest in it makes the January issue of Canadian Electronics Engineering one of the year's best advertising buys.

If you manufacture or supply electronic equipment, the Annual REVIEW & FORECAST presents you with an excellent opportunity to tell Canadian buyers about your products.

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CANADIAN ELECTRONICS ENGINEERING

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C.A.R tie-up expands their production range

More Canadian and American electronics firms are entering into licensing agreements. This follows moves away from American financed subsidiaries in Canada and in many cases Canadian ideas are being exported over the border.

One of the latest agreements is between Canadian Applied Research Ltd., of Toronto and the Transval Engineering Corporation, Culver City, California.

The agreement licenses the Canadian aircraft instrumentation firm to produce certain airborne transistorized power supplies developed by Transval. There will be future broadening of the working relationship to include other products which the Canadian firm will handle. Transval produce airborne radio equipment, transistorized power supplies, inverters and missile components.

Demonstration of Mufax equipment

Muirhead Instruments Ltd., of Stratford, Ontario, gave a demonstration of their latest Mufax equipment in the Canadian National Telegraphs offices, Toronto, recently.

The equipment will provide an inter-office or inter-factory automatic facsimile system over ordinary telephone lines. Anything written, typed or drawn may be transmitted.

The transmitter takes copy up to 14 x 8½ inches and the receiver functions automatically, recording on white translucent Mufax paper. Transmission time for full-sized copy is 6½ or 4½ minutes depending on the type of equipment.

New Building for Hammond

Hammond Manufacturing Company Ltd., transformer specialists, have moved into a new factory in Guelph. Previously they had two factories in the same town.

The new building covers 90,000 square feet and has increased facilities for laboratory research and testing. The metal equipment department has also been expanded.

Hammond, an all-Canadian company, have been manufacturing transformers for 30 years. They carry 1,000 different items as stock units. President and general manager is L. N. Hammond.

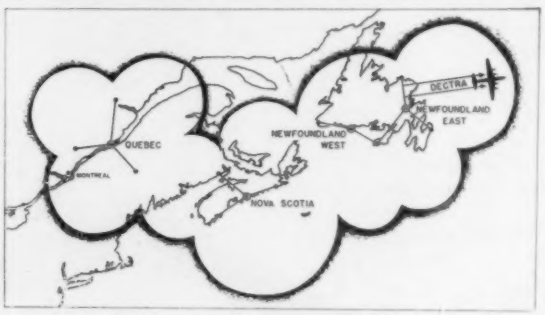
Bendix-Decca navigation chain opened

The Bendix - Decca Navigation chain is now in official use in the heavy traffic airways of Eastern Canada, after an opening ceremony by the Deputy Minister of Transport, John R. Baldwin.

The area-coverage system is based on electronic signals transmitted by ground stations, consisting of master and slave stations. The signals form wave patterns that become "concrete" lines along the airways.

A continuous position fix is provided by the intersection of the lines from two stations. The position information is recorded on dial indicators and also displayed automatically on the map of the flight log.

Canadian rights, both in manufacture and sales, are held by Computing Devices of Canada Ltd., Ottawa.



The one - million-square - mile area outlined on this map is covered by a new short-range radio navigation system for the precise control of air traffic. Called the Bendix-Decca air navigation system it was officially opened last month.

New Canadian Subsidiary of I T & T

The International Telephone and Telegraph Corporation have set up a new subsidiary called I T & T Electronics Service Company of Canada Ltd., in Montreal.

The Company will provide services ranging from the installation, operation and maintenance of telecommunication and electronic equipment, such as microwave links and radar networks, to the engineering of such installations and the evaluation of alternative systems for a given job.

TV used in metals structure X-ray

Harry Thomasson, manager of the Canadian Westinghouse mechanical-metallurgical research laboratories, reports, following a recent tour of the Continent, that European research techniques in X-ray TV of metals structure are particularly impressive.

Faster telegraphs in Eastern Canada

New equipment installed by Canadian National Telegraphs in its Moncton headquarters will result in a speed-up of telegraph traffic in eastern Canada.

Moncton will be a "torn tape" centre in which operators tear off individual messages and feed the tape into a nearby transmitter. This cuts out the older method of receiving, reading, pasting and re-teletyping, sometimes through two or more centres, and reduces the delay to a few seconds.

The equipment is capable of controlling 1,000 messages hourly to 6,000 CNT Maritime destinations.

TV retail price index goes down

Average selling price of television sets has fallen from $523 to below $300, a reduction of 40%, since 1951 according to RETMA. This compares to the almost constantly rising Government's consumer price index.

The RETMA report says: "The television industry has been able to achieve this reduction in consumer prices since 1951 by the application of the results of long-range research, advances in mass production techniques and by the rapid penetration of sales as television stations have opened across the country."

Sales figures for TV sets for this year to September were 295,338 (same period 1956, 411,562) and for radios 389,509 (1956, 370,370).

News in brief

Electromechanical Products of Agincourt, Ontario, representatives for Century Electronics and Instruments of Tulsa, Oklahoma, now have an airborne Electrograph Model 422E available.

Major defence contracts, in electronics, for the first two weeks in October: Alex L. Clark Ltd., Toronto, electronic equipment, $53,975; Rogers Majestic Electronics Ltd., Toronto, transmitters, $33,911; Canadian Marconi Co., Montreal, Quebec, installation and renovation of radio circuits, $30,730.

The Rogers Special Quality* 6689/E83F R.F. Pentode is designed specifically for use in instrumentation, industrial control equipment, carrier and communications equipment. It is a sharp cut-off tube of high transconductance and absolute reliability.

From an initial figure of 9000 ± 1200, the tube's transconductance is guaranteed not to fall below 6400 within 10,000 hours. It is designed and built to operate within published ratings and adhere to these ratings during its long life. The 6689/E83F is internally shielded and has silver or gold plated pins to minimize contact resistance and corrosion.

**Rogers Special Quality tubes are finding more and more applications in all types of professional equipment. The greater reliability and lower maintenance cost of the apparatus in which they are used more than compensate for the higher initial cost.*

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The outstanding electrical, chemical and mechanical properties of Teflon are opening new avenues for improved design in many industries. Teflon's unique combination of these properties is of particular value in the electrical and electronics industries and makes possible significant advances in the design of aircraft, guided missiles and all associated electronics equipment.

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TEFLON* INSULATED

FEDERAL'S NEW HIGH TEMPERATURE HOOK-UP WIRE

CONSTRUCTION — Federal's Teflon insulated hook-up wire has a silver coated copper conductor, insulated with an extruded wall of Teflon tetrafluoroethylene resin having an extremely uniform diameter. Where necessary, an overall Teflon enamelled glass braid and/or shield may be supplied.

Teflon insulated hook-up wire meets the requirements of military specifications MIL-W-16878 for types E and EE, rated at 600 and 1000 volts respectively, and MIL-W-7139 for type RM, rated at 600 volts. Supplied in 10 standard solid colours and up to 3 spiral stripes for circuit identification.

HEAT RESISTANCE — Teflon is suitable for continuous service at temperatures from 90° to 250°C. A hot soldering iron in contact with Teflon insulation will not damage it — particularly important where space is limited. As well as withstanding high ambient temperatures, Teflon also permits higher operating temperatures, making possible reduced conductor size with a saving in space and weight.

ELECTRICAL PROPERTIES — Teflon's low power factor, low dielectric constant, high volume and surface resistivity and good dielectric strength are all constant over a wide range of frequencies and temperatures.

CHEMICAL INERTNESS — Wherever there is danger of exposure to solvents or chemicals Teflon in many instances affords the only complete protection. Of all the chemicals encountered in commercial practice, only molten alkali metals and fluorine at elevated temperatures and pressures show any sign of attack on Teflon.

LOW COEFFICIENT OF FRICTION — Teflon has an exceptionally slippery surface — ideal when passing leads through sleeves or similar confined spaces.

Federal's Teflon insulated wire opens the door to new and improved design. Let us know *your* requirements now.

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Radio Communication Equipment
Air Radio Navigational Aids
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(Automatic and Manual)

Standard Telephones & Cables
Mfg. Co. (Canada) Ltd.

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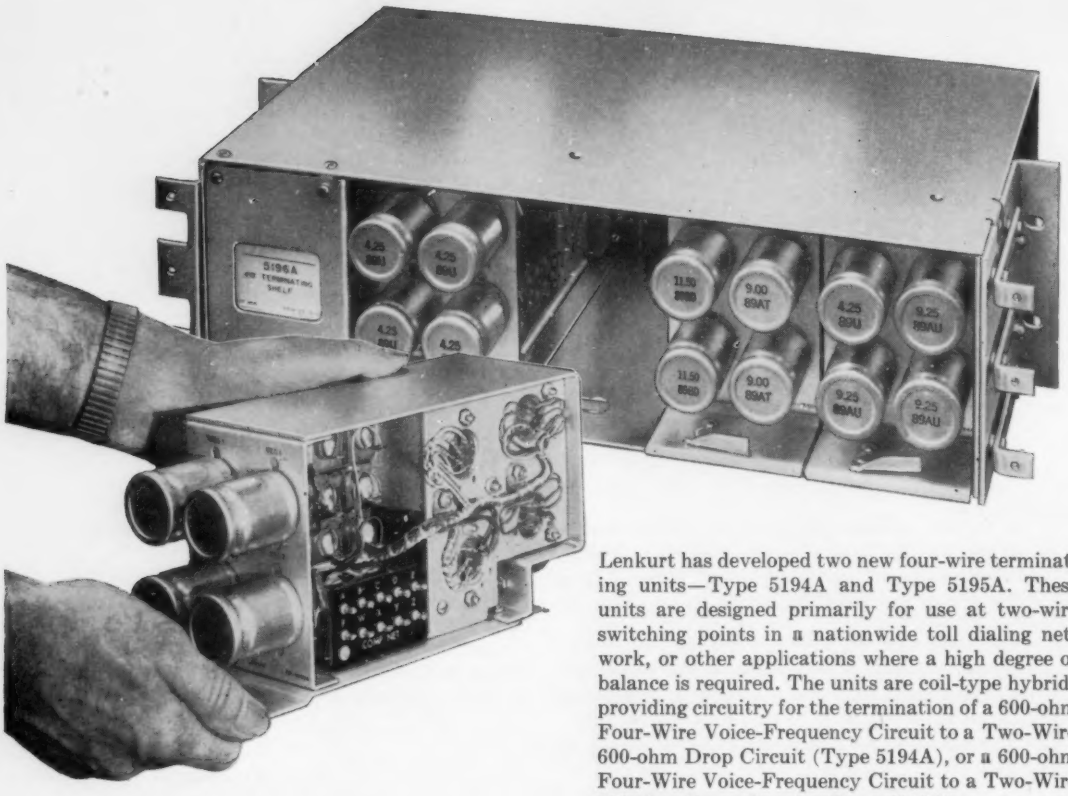

Lenkurt has developed two new four-wire terminating units—Type 5194A and Type 5195A. These units are designed primarily for use at two-wire switching points in a nationwide toll dialing network, or other applications where a high degree of balance is required. The units are coil-type hybrids providing circuitry for the termination of a 600-ohm Four-Wire Voice-Frequency Circuit to a Two-Wire 600-ohm Drop Circuit (Type 5194A), or a 600-ohm Four-Wire Voice-Frequency Circuit to a Two-Wire 900-ohm Drop Circuit. (Type 5195A).

Each terminating unit has provision for connection to an adjustable built-in compromise network, or to an external precision balancing network, as well as facilities for A and B lead or simplex signalling. Lenkurt Four-Wire Terminating Units are mounted on a single shelf for 19-inch rack mounting.

Write for complete information.

Automatic Electric Sales (Canada) Limited, 185 Bartley Drive, Toronto 16, Ontario. Branches in Montreal, Ottawa, Brockville, Hamilton, Winnipeg, Regina, Edmonton, Vancouver.

AUTOMATIC ELECTRIC

ORIGINATORS OF THE DIAL TELEPHONE

5775

How can we improve our technical education?

Sputniks I and II will have been silent for some time when this issue reaches our readers. However, they will most certainly not have been forgotten.

Little could be learned in the West from the radio signals received during the active life of either satellite. The transmission methods and frequencies used were different from the ones agreed upon by the nations participating in International Geophysical Year programs, and some reports from Europe and Africa suggest that information was only being transmitted over the Eastern hemisphere.

One outstanding lesson could, however, be learned from the Soviet success as a whole: that the U.S.S.R. can no longer be regarded as inferior to the Western powers in its ability to educate, train and utilize technical manpower.

Much has been said and written in recent weeks about the vital necessity of co-operative effort to meet the new challenge. It is also considered vital for our long-term success that we take a much closer look at our whole approach to technical education, both in terms of the number of people receiving it and of the type of course provided.

On the question of numbers, the Russians appear to be establishing a significant lead. Although the present strength of engineers and scientists in the Soviet Union and North America are estimated to be roughly equal, their current rate of engineering graduation is approximately 80,000 per year, compared with less than 30,000 in the United States and about 2,000 in Canada. Many experts feel that the training of Soviet graduates in engineering and science is probably of better quality than our own, while most seem to agree that it is not any worse.

Many questions immediately suggest themselves: teacher training, attitudes and salaries; high-school curricula and the attitude of students toward their studies; the competitive appeal of certain types of non-technical employment; the type of course presented by university engineering and science faculties; the quality — and again remuneration — of university lecturers; etc., etc. We feel that a full-scale investigation of the whole situation is in order, and were therefore most pleased to learn of one important move that is being taken in this direction.

The first Canadian Conference on Education is to be held in Ottawa on February 17-20, 1958. Sponsored by 19 bodies including the E.I.C., teachers' federations, chambers of commerce, manufacturers' associations, the conference will be national in scope and several hundred delegates are expected to attend. Its basic purpose will be: To focus attention on the objectives and needs of education in Canada in the next decade and to seek ways and means to meet them.

We urge all our readers to support this vital conference and to feel free to use our pages to express their opinions on the many facets of this problem.

THE EDITOR

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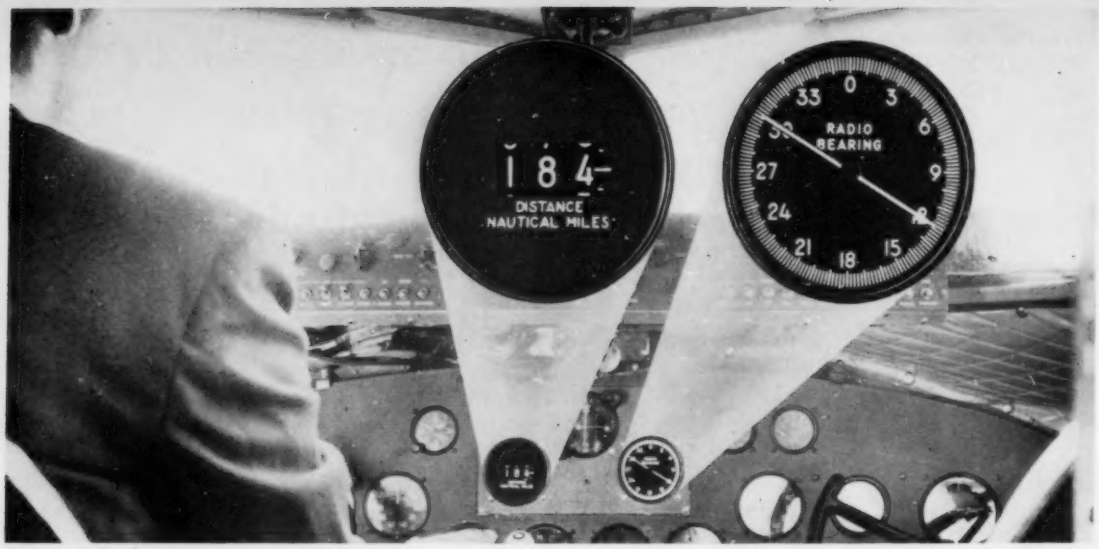


Pilot selects channel then reads aircraft bearing and distance from ground beacon on these easy-to-read instruments

TACAN gives pilot continuous indication

TACAN is a radio air navigation system of the polar co-ordinate type, illustrated in figure 1. That is, there is an "omnirange" or bearing facility which provides the aircraft with a meter indication of its direction, in degrees of bearing, with respect to the geographic location of the ground beacon tuned in by the pilot. Then there is a DME or distance facility which provides the aircraft with a meter indication, in nautical miles, of its distance from the selected ground beacon. Knowing his bearing and distance from a specific geographic point, the pilot can fix his position on a chart; navigation and traffic control are thereby facilitated.

The system has been developed for the United States Navy and Air Force by Federal Telecommunication Laboratories, and manufactured by Federal Telephone and Radio Company, both divisions of the International Telephone and Telegraph Corporation.

The bearing function in the system is of a general type known as "omni-directional radio range" (abbreviated ODR or omnirange) in distinction to other directional radio navigational systems such as four-course ranges, radio compasses, direction finders, etc. DME is an abbreviation for distance measuring equipment; properly speaking, it refers in general to any radio aid which furnishes meter indication of distance. The expression Tacan is a code word for "tactical air navigation system." The military nomenclature for the equipment is AN/ARN-21 (airborne) and AN/URN-3 (ground or shipborne).

System features

An omnirange system requires: on the ground, a transmitter in association with a special directional antenna; on the aircraft, a multichannel receiver. A DME system requires: on the ground, a receiver-transmitter combination ("transponder") with a nondirectional antenna; on the aircraft, a multichannel transmitter receiver combination ("interrogator"). The ground equipment or stations are frequently referred to as "beacons."

The elements of Tacan are indicated in figure 2. The entire system operates in the 1000-mc band. One multichannel airborne receiver-transmitter, operating with pulses, provides both distance and omnirange functions. That is, the same radio signals, on any given r-f channel, convey both distance and bearing information. Actually, both a "coarse" and a "fine" bearing system are included in the omnirange function. Only one airborne antenna and channel selector are required.

Tacan has 126 two-way operating channels available for assignment. The adjacent channels are spaced one megacycle apart in radio frequency. For air-to-ground transmissions (required only for the distance function) there are 126 frequencies within the band 1025 mc to 1150 mc. For ground-to-air transmissions (serving both bearing and distance functions) there are 63 frequencies in the band 962 mc to 1024 mc plus 63 frequencies in the band 1151 to 1213 mc. The Tacan channels are "clear frequencies." By this term it is meant that the channels are established solely on the basis of radio frequency, and not by employment of pulse coding. Pulse coding, that is, the transmission of characteristic pulse groups with some prearranged spacing between component pulses of the group, is used in Tacan to increase the average radiated power, or the signal-to-noise ratio; to discriminate against pulse interference; and also for the purpose of multiplexing the bearing or omnirange function on the DME channels.

Tacan's saving in weight and size of airborne equipment and in r-f-spectrum requirements would be even more pronounced if one were to take into consideration all the present navigational functions which might be multiplexed on its channels. These now operate individually, as follows:

W. ARTHUR STEEL*

The TACAN radio navigation system provides military or civil pilots with continuous, precise distance and bearing information for navigation. It has an effective range of up to 200 miles and comprises both ground beacons and airborne equipment. The system has been under development for the last ten years but military security restrictions have limited the release of detailed information until recently.

# of aircraft position

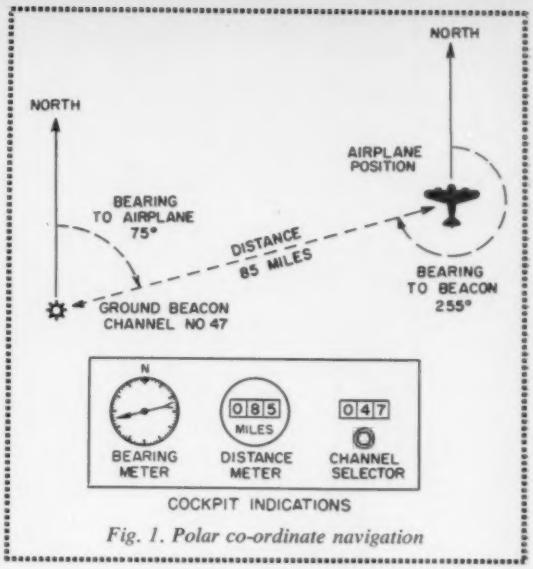


Fig. 1. Polar co-ordinate navigation

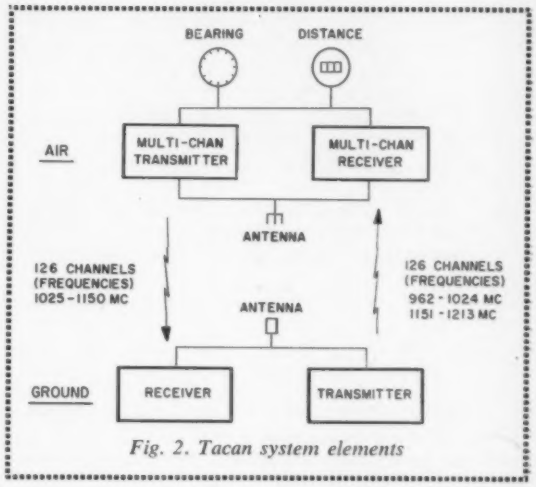


Fig. 2. Tacan system elements

vhf omnirange, 112-118 mc; civil DME, 936-986 mc and 1188-1210 mc; air traffic control transponder, 1030 mc and 1090 mc; ILS localizer, 108-112 mc; ILS glide path, 328-335 mc; and marker beacon, 75 mc.

In Tacan operation there is no possibility that, because of the pilot's error in manually pairing channels on separate omnirange and distance equipments, or because of malfunctioning of an automatic channel pairing mechanism, bearing might be received and indicated from one ground station and distance from another ground station, with consequent confusion in navigation. It is impossible because the two services are provided by the one radio set, on one operating channel. This situation is quite analogous to modern television service, where one r-f channel conveys the signals for both the picture and the sound.

DME operating principles

Distance measuring equipment is an outgrowth of radar ranging techniques, whereby distance is determined by measuring the round-trip time of travel of radio pulse signals between the two points in question. In DME, however, instead of cathode ray tubes, easy-to-read meters are used to display the distance readings. Also, instead of depending on natural reflections or echoes for the return trip of the pulses, a radio transponder or beacon is used to produce artificial echoes. These artificial responses are stronger, and their radio channel positively identifies the source of the "echo" and hence the geographic location of the echoing point.

Referring to figure 3, the airborne transmitter repeatedly initiates a process of sending out very narrow, very widely spaced "interrogation" pulses. These are picked up

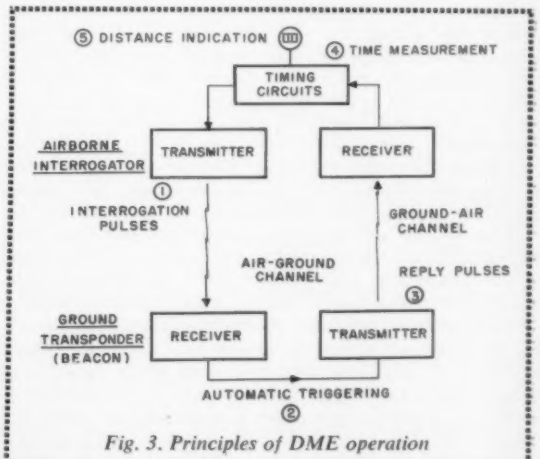
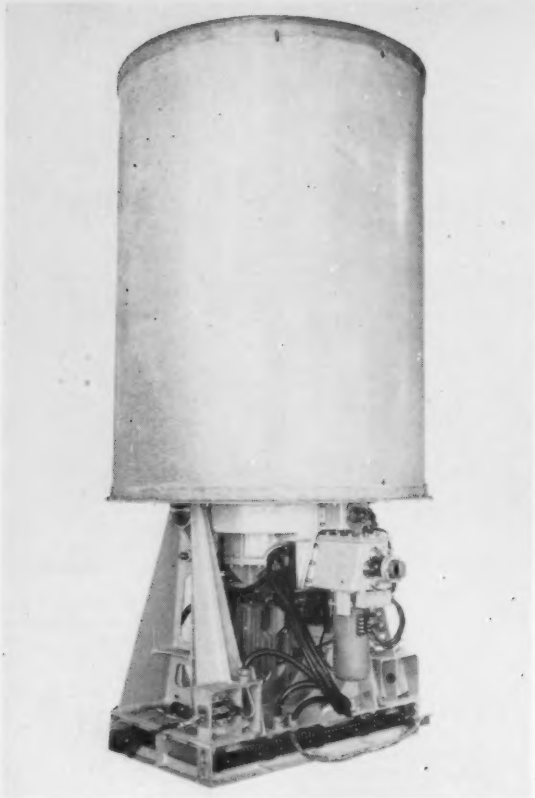


Fig. 3. Principles of DME operation

*Standard Telephones & Cables Mfg. Co. (Canada) Ltd., Montreal.



View of Tacan shipboard antenna showing driving motor and stabilizing equipment. Ground antenna is mounted on an unstabilized base, but is otherwise identical.

by the ground beacon receiver, whose output triggers the associated transmitter into sending out "reply" pulses on a different channel. These replies are finally picked up by the airborne receiver. Timing circuits automatically measure the round-trip travel time, or interval between interrogation and reply pulses, and convert this time into electrical signals which operate the distance meter.

In system operation, a given ground beacon may be interrogated simultaneously by a number of aircraft which are in the vicinity and which have tuned to its channel. The ground beacon will then reply to all interrogations, and each aircraft will receive the sum total of replies to all aircraft. To permit interference-free operation under such normal conditions, it is arranged that each aircraft's interrogation pulses occur at a rate that is intentionally permitted to "jitter," or vary (within certain limits) in an irregular or random manner. The jitter effect is obtained essentially by permitting a nonstabilized multivibrator circuit to exercise gross control over the interrogation rate. In order to determine which ones among all the reply pulses received on a given aircraft are replies to that aircraft's own interrogation pulses, a stroboscopic "search" process, entirely automatic in operation, is employed.

The "strobe" locates the proper reply pulses by finding out the one fixed (or very slowly changing) time delay, measured always from its own previous interrogation pulse, at which a reply pulse is repeatedly received. Because of the fact that interrogation pulses on other aircraft are nonsynchronous or random with respect to the given aircraft's interrogation pulses, reply pulses corresponding to such "foreign" interrogation pulses will not be received regularly, at any one fixed (or very slowly changing) time delay, on the given aircraft.

The time measuring circuits have a memory provision, so that if for some reason reply signals fail to be received for a certain short length of time, up to approximately 10 seconds, the pre-existing distance indication will be maintained without the search operation being restarted.

By strobe principles, which are common to all types of DME, many (more than 100) aircraft may simultaneously, and without mutual interference, obtain distance service from one ground beacon. Pulse interrogation rates from each aircraft, during tracking operation, are of the order of 24 per second; they are temporarily higher, approximately 150 per second, during the search process. The over-all average rate is considered to be about 30 per second, on the basis that the average aircraft within range will be "tracking" 95 per cent of the time and "searching" 5 per cent of the time. The pulses are very narrow, of the order of 3.2 microseconds. Hence the "duty cycle," or percentage of any total time interval during which r-f energy is being transmitted, is very low. The average interval between successive DME interrogation pulses from one aircraft is approximately 33,000 microseconds; the average interval between successive reply pulses to 100 aircraft is approximately 370 microseconds. It is evident that in DME operation, even with 100 aircraft receiving service from a beacon, the r-f channels are mostly empty, very large spaces existing between successive pulses.

In actual designs of DME, the pulse signals are generally twin pulses, with a prearranged spacing between the components of the twin. The receivers, ground and airborne, are followed by discriminators or twin pulse decoders, which are adjusted so as to pass only pulse pairs of the prescribed spacing. Isolated single pulses, or pulse pairs with some other spacing, will not pass the decoder. Purposes of the twin pulse technique are to increase the average power radiated and to make the system less susceptible to errors or interference caused by false signals.

Bearing indication function

The Tacan omnirange operates in the 1000-mc region, which makes it possible to be multiplexed with the DME, and makes it practical to incorporate a number of other advantageous features. The heart of any omnirange is the ground beacon antenna system. This must produce a specified directional radiation pattern, and somehow this pattern must be rotated or switched around a vertical axis. For similar radiation patterns, the required physical dimensions of the antenna array depend on the operating radio frequency, or the wavelength. Between the 100-mc vhf band and 1000-mc Tacan band there is a ten-to-one reduction in wavelength. This fact is substantially reflected in the order of magnitude of the dimensions required for comparably performing vhf and Tacan ground beacon antennas. This ten-to-one advantage can be employed to increase the Tacan antenna size considerably, in terms of wavelength, for superior performance, and still result in a quite small antenna.

In a Tacan ground antenna installation the extreme diameter, that of the cylindrically shaped protective cover, is approximately 3½ ft.; total height of the assembly, including antenna proper and motor drive, is around 6 ft. This assembly contains both coarse and fine omnirange, and DME antenna elements. If the Tacan omnirange function were to comprise only a coarse or cardioid system, the extreme diameter of the antenna would be even smaller —under one foot. No counterpoise is required, hence the antenna may be installed on a tower or on a ship's mast.

Antenna and coarse omnirange

Figure 4 illustrates (not to scale) the arrangement of the ground beacon antenna, in plan and perspective views. The only portion of it which is fed with r-f energy from the transmitter is the central element, shown here as a vertical rod. This is stationary and has no directivity in the horizontal plane. Actually, by itself, it is a conventional Tacan DME antenna, which is a vertical stack of "discone" radiators; its diameter is about three inches.

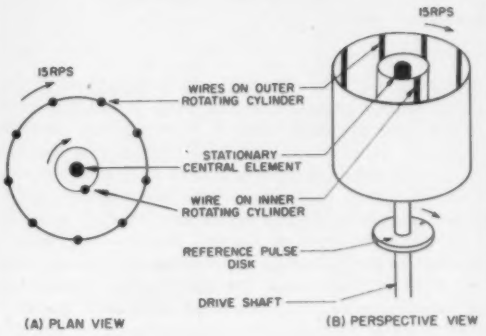
Around the central element is an inner cylinder of insulating material (Fiberglas) with a diameter about five inches. Attached to or embedded in this cylinder is a vertical metal wire which is completely isolated. The wire acts as a parasitic antenna, or reflector, since it intercepts some of the energy radiated toward it by the central element, and reradiates it. Its distance from the central element is figured, in terms of wavelengths, so that it has the effect of distorting the original circular radiation pattern of the central element into a cardioid. This pattern is plotted at (A) in figure 5. The cardioid pattern is bodily rotated by means of mechanical rotation of the inner cylinder. Since no energy is fed from the transmitter to the rotating wire, no sliding contacts are required. The rotation rate is 15 rotations per second. Physically, the cylinder is supported by bearings at top and bottom.

As a result of the rotation of the cardioid radiation pattern, the signal received along any given direction from the beacon goes through corresponding cyclic variations in strength as a function of time—identical to what an airborne receiver would experience if it were flown around a stationary cardioid pattern at 15 orbits per second. The nature of these variations may be shown by replotting the polar co-ordinate pattern in rectangular co-ordinates, with time replacing direction angle as the variable of interest. Figure 5 (B) is such a plot; the vertical axis represents signal strength (envelope of r-f) and the horizontal axis represents time. A cardioid thus transformed into rectangular co-ordinates is simply a sine wave. (For this discussion the d-c component may be neglected.) Since the cardioid is a single-lobed pattern, it takes one full turn of the antenna pattern, or 1/15 second, for the received signal to go through one complete cycle of variation, that is, from maximum to minimum to the succeeding maximum. In short, the airplane receives a 15-cycle-per-second modulation, from which an audio sine-wave signal may be extracted by radio detection methods.

In omniranges it is the electrical phase of the audio signal which is important. Referring to the polar plot, figure 5 (A), it is clear that if at a given instant of time the maximum of the lobe points due north, then the maximum will not aim due east until some time later (1/60 second to be exact). This is a way of saying that along progressively clockwise directions around the beacon the electrical phase of the received 15-cycle-per-second audio modulation is progressively retarded in comparison with the phase received due north. In the particular case of the cardioid, a single-lobed pattern, there is a one-to-one correspondence, that is, for each degree of geographical bearing change, there is a one degree change in electrical phase of the 15-cycle-per-second audio signal. It is only necessary to measure the electrical phase of the received signal, and to use it to position the pointer of a bearing indicator.

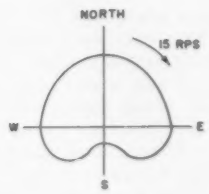
For the phase measurement to be performed, a suitable reference signal is required. For this purpose, pulse signals transmitted at some fixed phase and at the correct frequency (15 cps) serve as well as a complete wave. These signals are actually sent out each instant that the maximum of the rotating cardioid pattern aims due east. These 15 cps or "coarse reference" signals are distinguished

How coarse omnirange system operates

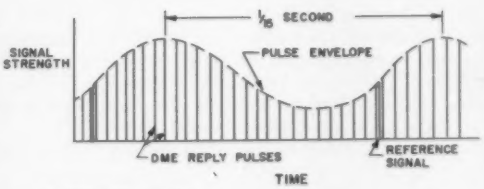


NOTES:
1 – NOT TO SCALE.
2 – STATIONARY ENCLOSING RADOME NOT SHOWN.

Fig. 4. Ground beacon antenna



(A) CARDIOID PATTERN – INNER CYLINDER EFFECT



(B) DETECTED SIGNALS

Fig. 5. Radiation pattern

Isolated wire on inner cylinder distorts circular radiation pattern of central antenna element into a cardioid shape. Rotation of cylinder at 15 rps causes received signal in any given direction to fluctuate at 15 cycles per second. Aircraft bearing is established by comparing phase of received signal with that of reference signal transmitted each time cardioid pattern maximum is aimed due east.

from the DME signals in the following manner: The DME replies (or the filler pulses) are 12 microsecond twins which occur at an irregular rate, but averaging about 2,700 per second; hence the interval between these signals is somewhere in the vicinity of 370 microseconds, with some variation in this figure. The 15 cps reference signal, on the other hand, is a precisely regular group, consisting of 12 pulses (each a 12 microsecond twin) spaced exactly 30 microseconds apart.

Fine omnirange

Referring back to figure 4, the inner cylinder has a diameter of only some five inches. Now attention is directed to the outer cylinder, which is approximately 33 inches in diameter. It is constructed of Fiberglas like the inner cylinder, and rotates integrally with it at 15 cps. The outer cylinder, however, has nine wires embedded in it. The wires are spaced uniformly 40 degrees apart. These wires also are parasitic, non-fed antenna elements, and have an intentional distorting effect on the heretofore considered cardioid pattern produced by the central antenna and inner cylinder wire. The resulting composite pattern is plotted in polar co-ordinates at (A) in figure 6. The overall cardioid or single-lobed variation is still present, and predominant in fact. Superimposed on this pattern are nine secondary variations or ripples. The maxima of these ripples, or minor lobes, are spaced 40 degrees apart.

To indicate the nature of the cyclic variations in pulse amplitude received by an aircraft at a given bearing, the composite radiation pattern is transformed into rectangular coordinates.

This envelope signal has a basic 1/15-second period, as before, because of the predominant fundamental component due to the 15 cps rotation of the inner cylinder.

The outer cylinder also makes one complete turn in 1/15 second, but this causes nine ripples or minor lobes to sweep past the aircraft. Hence the composite envelope wave also contains a 9th harmonic sine-wave component, with a frequency of 15 x 9 or 135 cycles per second. The 135-cps and the 15-cps sine-wave components are separable by means of filter circuits, and the electrical phase measurement is performed on each.

To furnish a suitable reference for measuring the phase of the 135-cps component of the envelope wave, the ground equipment is arranged to transmit appropriately timed and coded 135-cps reference signals, in a manner similar to that explained for the coarse system.

To resolve the ambiguity of the 135-cps phase measurement, the 15-cps phase measurement is used. The 15-cps measurement has more than enough accuracy for this purpose.

In the Tacan instrumentation, the 15 cps coarse system phase-measurement initially only moves the pointer to within the correct 40-degree bearing sector, and thereafter ensures that it remains in that sector. The exact postioning of the pointer within that sector is under control of the 135-cps fine system phase measurement, suitably geared down.

System performance

Complete system errors include instrumental and propagational or site errors. The latter errors are quite variable depending on the location. All omnirange errors are very substantially reduced by the fine system.

Average omnirange complete system errors are about ¾ deg. Distance accuracy is fundamentally limited by the pulse widths used, but in practice depends largely on the refinement of the time measuring circuits employed in particular models of airborne equipment. DME system accuracy is about ± 600 ft. plus 0.2% of the distance measured.

In the vhf and in uhf bands, service range is limited not only by transmitter power and receiver sensitivity, but more practically by line-of-sight considerations, as determined by the airplane's altitude. Tacan omnirange service extends out to 200 nautical miles or more, subject to line-of-sight limitations. DME service, in practice, is additionally limited by the built-in maximum "search range" of the strobe circuits and the associated maximum scale of the distance meter. The Tacan DME serves out to 200 nautical miles and so matches the range of its associated omnirange function.

Front panel of channel-selector control box has extremely simple layout, with digital display of chosen ground beacon channel number. Panel shows result of applying human engineering principles in the design stage. (See CEE for September, 1957.)

VORTAC decision incorporates

On Aug. 30, 1956 the Air Coordinating Committee (ACC), the top-level aviation policy-making agency in the United States, released its decision on the Tacan vs. VOR-DME controversy. This decision set up a new combined system called "VORTAC" which incorporates Tacan into the new common system for air navigation.

The original plan prepared by the Radio Technical Commission for Aeronautics (RTCA) called for a 100 mc bearing system known as "VOR," combined with a 1000 mc distance measuring system called "DME." The RTCA plan recommended that any DME initially installed, should be of a type that would not be obsoleted when a combined 1000 mc bearing and distance system was developed.

The military Tacan system is essentially a combined bearing distance system operating at 1000 mc. There is no operational bar to simultaneous utilization of Tacan and VOR, since these two systems operate in totally different RF bands. In line with the RTCA plan, VOR has been extensively implemented and is widely used, and there is no need for, nor any danger of, jeopardizing the investment in VOR equipment.

With respect to DME, however, a type of 1000 mc DME was introduced as a companion to the interim VOR in a nominal manner, but has never gained widespread acceptance as measured by number of airborne installations. This civil DME used a pulse-code-multiplex system for obtaining channels, whereas the Tacan DME uses clear radio frequency channels in the conventional manner employed in radio communication and navigation equipments. Thus, there is a conflict between the 1000 mc band pulse-code-multiplex channels and the 1000 mc band Tacan clear channels, effectively preventing simultaneous utilization of pulse-code-multiplex DME and Tacan. This has been the major point of issue in the recent so-called "VOR/DME-TACAN controversy."

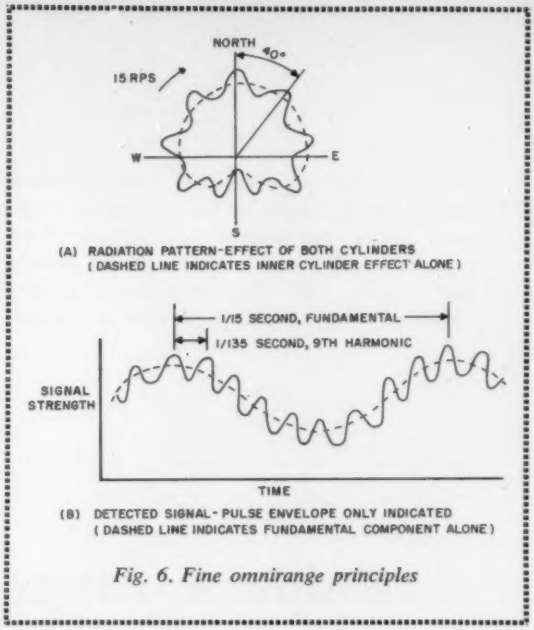


Fig. 6. Fine omnirange principles

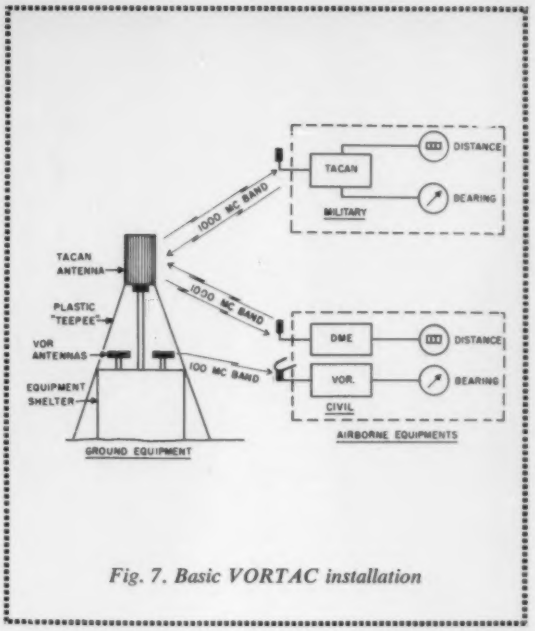


Fig. 7. Basic VORTAC installation

Tacan in new common navigation system

Summarizing, these facts were known to all and undoubtedly were recognized by the ACC in its efforts to resolve the issue:

(1) The original RTCA plan, endorsed by the ACC at its inception, envisaged a common system of air navigation to be used for both civil and military aircraft.

(2) The pulse-code-multiplex DME was incompatible in general with the eventual development of a combined 1000 mc bearing/distance system recommended by the RTCA plan.

(3) The pulse-code-multiplex DME was incompatible in fact with the 1000 mc bearing/distance system (Tacan) adopted for military use.

(4) The pulse-code-multiplex system of channelling was unconventional and had grave operational disadvantage even for a system considered by itself.

(5) Because of the facts just cited, there was consumer reluctance to invest in airborne pulse-multiplex DME, as evidenced by the fact that only 123 installations have been made, none by commercial airlines.

Therefore, it appeared most logical and least costly to break the deadlock by changing the civil DME specification from one with unconventional pulse-code-multiplex channels to one with conventional clear frequency channels as used in Tacan. This change is the keystone of the ACC decision.

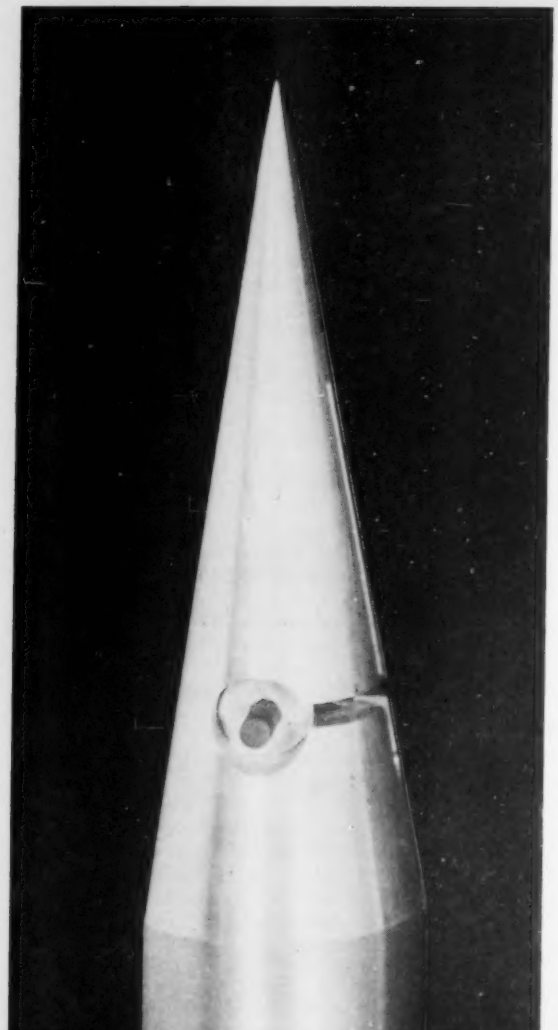
The consequences that will result from the ACC decision are as follows. Military aircraft will be able to obtain bearing and distance services from their 1000 mc integrated airborne Tacan equipment, designated AN/ARN-21, of which thousands of sets have been built. Civil aircraft will continue to be able to obtain bearing service from their 100 mc airborne VOR sets, of which thousands of sets have been built. Civil aircraft operators who desire distance service will be able to obtain it by adding an airborne 1000 mc Vortac DME of the clear channel type, which operates in conjunction with the distance portion of either civil or military Tacan type ground stations. This implies no extra quantity of airborne equipment for distance service beyond that which would have been required to obtain VOR/pulse-code-multiplex DME service.

The commercial or civil Vortac DME to be offered in the near future is shown in figure 7. It is designed around the civil airlines' equipment specification for Vortac DME. At the same time, a separate Tacan-type bearing adaptor will be available, for plugging into the Vortac DME. This will enable civil aircraft operators to obtain the superior Tacan-type bearing indications, either in addition to the VOR bearing service or possibly as an eventual replacement therefor.

As regards the ground portion of the Vortac system, the basic installation as indicated by figure 7, consists of a VOR beacon, to provide 100 mc bearing service to VOR equipped aircraft; plus a civil or military Tacan beacon, to provide 1000 mc distance service to civil aircraft equipped with Vortac DME, and at the same time 1000 mc distance and bearing service to military aircraft equipped with Tacan or civil aircraft equipped with Vortac DME plus the bearing adaptor.

In conclusion, the decision of the Air Coordinating Committee permits both military and civil aircraft operators to employ the navigational facilities which they desire, without conflict, with flexibility and with minimum obsolescence of equipment already installed. END

Based on the article Principles of Tacan by R. I. Colin & S. H. Dodington (Federal Telecommunication Laboratories, Nutley, N.J.), Electrical Communication, Vol. 33, No. 1, March, 1956.



Time-consuming methods used in recording data on ballistic missile ranges can be replaced by a telemetry system. This requires the design of a transmitter to fit into a missile three inches in diameter and 16 inches long. The transmitter allows information on a flight to be recorded instantaneously.

Ballistic range

DAVID L. DUFF*

Apart from free-flight models, Aero-dynamic research on missiles and air-frames has been conducted largely in various types of wind tunnels. However, in wind tunnel research, it is difficult to simulate free-flight conditions. This is particularly difficult when dynamic information in either the longitudinal or roll direction is required. To obtain this information, a ballistic range is used. This consists of a long building where small scale models of missiles are fired from one end to the other by means of a special gun. The models to be fired are surrounded by a sabot to take the force of the powder charge. The sabot leaves the model after emerging from the barrel of the gun and the model flies free down the length of the range.

The information regarding its flight is at present obtained in two ways. These are the optical method and a method employing YAW cards. In the first method, a photographic record is made of the missile in flight as it passes various monitoring points in the range and positional and attitude information are thus obtained. In the other, the missile is allowed to pass through a series of thin paper cards set up at close intervals along the range and a study of the pattern made by the missile gives the dynamic motion of the missile during its flight. The mass and kinetic energy of the model are so great that no measurable effect on the path of the missile is noticed due to its passage through the cards.

Both these methods require complicated and time-consuming techniques for obtaining the forces present on the missile. The method to be described gives lateral accelerations and roll-rate directly without the need for the laborious methods used previously. Dynamic records of the missiles' flight at all instants of time are immediately available without the necessity for time consuming data-reduction. Many firings a day may be made and the usefulness of the firing facilities increased correspondingly.

Briefly, the basic requirements for such a telemetry system are as follows. A small, lightweight, and extremely rugged transmitter is to be fitted within the ballistic model.

*Canadian Westinghouse Company Ltd., Hamilton, Ont.

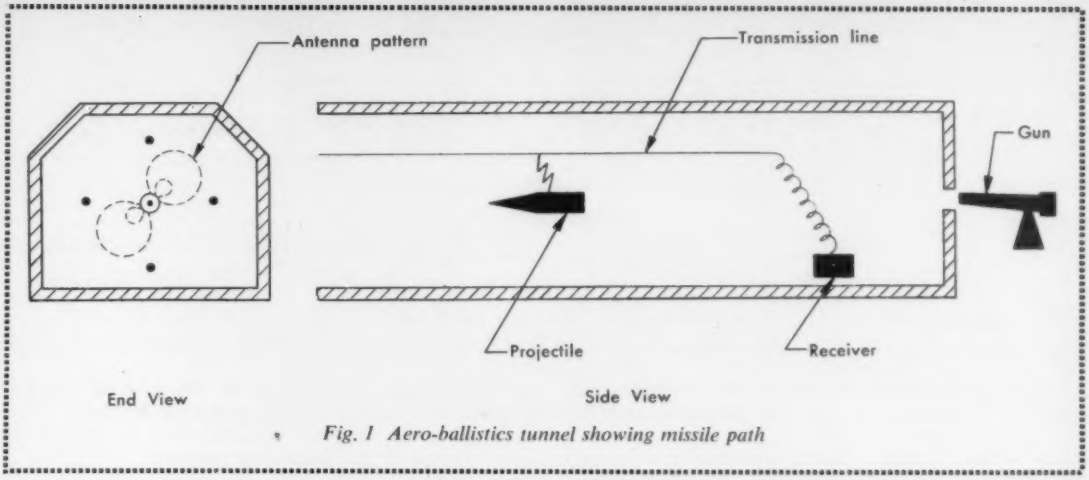


Fig. 1 Aero-ballistics tunnel showing missile path

telemetry system speeds data recording

The signal from this model will then be received by fixed receiving stations and the information recorded.

The system to be described is capable of transmitting information from within a small ballistics model. This model is required to endure a very severe initial acceleration varying from 5,000 to 20,000 g's, and will leave the muzzle of the gun at a super-sonic speed of 3,000 ft./second or about 2,000 miles per hour. The flight from one end of the tunnel to the other has a duration of ½ second. The projectile is 3 in. in diameter and 16 in. long but this size can vary.

The initial system which has been devised is shown in figure 1. Three transmission lines are strung down a portion of the range. The voltages induced in these lines by the transmitter antenna radiation with respect to a fourth (ground) wire are fed to the input of three receivers.

The projectile follows a stable trajectory enabling it to fly along the centre of the 750 ft. long tunnel. This permits the use of near field techniques which in turn allow the use of low radiated power at reasonably low frequencies. Normal telemetry techniques would require high power at vhf or uhf to energize an antenna sufficiently small to fit in the projectile. The three lines form a type of diversity reception system which ensures an adequate signal in at least one receiver at all times.

These receivers are high-gain superheterodyne wideband receivers containing both amplitude and frequency modulation detectors. The outputs are fed via cathode followers to a cathode-ray tube recorder situated remotely in the recorder building.

The antenna radiation pattern contains two null points and a spin on the missile would result in an amplitude modulation of the signal. This amplitude modulation is used to detect the spin or roll-rate of the missile, but can also affect the f-m discriminator response due to inadequate limiting, so the diversity reception scheme was devised. The f-m channel will be used to record acceleration and temperature information.

The transmitter package will ultimately fit within a model from one to two inches in diameter with an available length of from eight to ten inches. The first prototype package fits into a missile three inches in diameter and sixteen inches in length. The available space for the package is two inches in diameter and three inches in length. The weight for this prototype is not critical but it is expected that close tolerances will be required for future models.

The power source for the package must be self-contained with an operating life long enough to permit testing before the actual firing takes place. The antenna can be mounted externally and at present is mounted in a slot in the nose of the projectile.

The instrumentation in the package will include specially designed accelerometers to measure three components of lateral accelerations in two planes and a temperature bridge network for measuring surface temperatures. These will have to be extremely rugged and sufficiently small to fit within the aeroballistic model. The telemetry transmitter in the prototype form consists of a frequency modulated oscillator with a centre-frequency between 6 and 8 mc. This is modulated by a sawtooth function generator situated within the package, operating at a frequency of 40-60 cps. The purpose of this sawtooth modulation is to measure the accuracy of the system. The intensity of modulation gives a frequency deviation of about 10 kc. The oscillator is coupled to a ferrite antenna in the nose of the missile by a buffer-driver stage.

Receiver is isolated

The receiver should be isolated from the effects of the shock wave present in the ballistics tunnel due to the explosion of the gun. It is proposed that this be done by installing the receiver in a soundproof enclosure with appropriate vibration isolation mountings. In addition, the stabilized power supply should be similarly isolated to prevent transients due to shock waves from appearing on the high voltage B+ line. A block diagram of a prototype receiver is shown in fig. 2. It consists of a cascade r-f amplifier stage fed from the antenna transmission line.

The signal is mixed with the local oscillator signal and

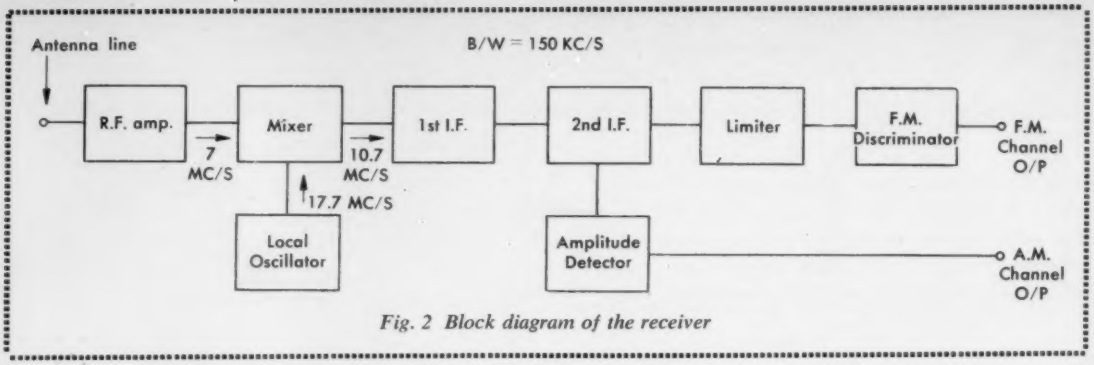


Fig. 2 Block diagram of the receiver

the resultant signal fed into a 10.7 mc i-f amplifier. The amplitude detector is fed from the second i-f amplifier. The output of the i-f is used to drive the limiter stage which in turn is fed to the Foster-Seely discriminator stage. The fm channel output feeds a cathode follower which supplies the signal to the recorder via a long coaxial line. The recording unit is a 6-channel cathode-ray tube photographic unit using high gain amplifiers on each channel with a frequency response or 0-100 kc.

The projectile transmits a frequency-modulated signal which is coupled inductively to the antenna transmission lines via the ferrite antenna. This is modulated by a saw-tooth generator included in the package. A special ferrite-cored tank coil is used, the inductance of which can be varied to give the desired frequency modulation of the oscillator.

The modulation coil is wound on the centre leg of an E-core, with the two outside legs being used for the oscillator coil windings. The coils are connected in such a way as to prevent any r-f flux from passing through the centre leg. Thus the modulation coil serves only to change the inductance of the oscillator tank circuit, and does not introduce any amplitude modulation. The coupling coil to the buffer is wound over the oscillator windings and separated by an electrostatic shield to prevent capacitive coupling.

The transistor oscillation (fig. 3) is a Colpitt's circuit and uses capacitive voltage division for feed-back with a grounded-base circuit configuration. The Colpitt's circuit was used to enable frequency modulation by varying the inductance of the tuned circuit. The resonant frequency is determined by $L_1(C_1+C_2)$. The battery impedance is reduced by the use of C_8 across it. R_3 C_3 is a biasing network in the emitter circuit. R_1 and R_2 comprise a voltage divider that eliminates the necessity of having dual polarity power supply to furnish emitter bias current and collector operating voltage. The ratio of C_1 to C_2 for self-sustaining oscillation depends on the current amplification and must be greater than $\frac{1-\alpha}{\alpha}$

The capacitor C_4 bypasses the base resistor R_2 to reduce the degenerative feedback. The output from the unmodulated oscillator is a sine wave of 7.5 mc. The modulation voltage drives the oscillator above this frequency an amount depending on the intensity of the current which causes the inductance to be decreased. In the prototype, the modulation bandwidth is about 10 kc.

The driver stage is included to isolate the oscillator from any external signals or objects which would tend to pull the oscillator frequency. It consists of a grounded-emitter amplifier driven from a winding on the oscillator coil. The antenna and a specially designed variable capacitor comprise the tuned circuit in the collector. The antenna is made from a 3/8 inch ferrite rod wound to give an inductance of about 30 uh. The variable capacitor consists of two printed circuit plates separated by a .002 inch polythene dielectric. This is tuned by turning the top bulkhead of the transmitter package.

How the modulator works

The modulator (fig. 4) consists of a transistorized emitter-coupled free-running multivibrator modified to give a saw-tooth function. The waveforms of this circuit demonstrate its operation. The function obtained at the base of TR2 shows the sequence of events which take place. At A, TR1 initially conducts and the charge on C_2 biases TR2 to cutoff. C_2 discharges through R_4 and R_5 and TR2 starts to conduct at B. The emitter potential cuts off TR1 and C_2 charges through the base of TR2 till at A^1, the cycle repeats. The time constant from A to B is $C_2(R_4+R_5)$ and from B to A^1 is $C_2(R_b+R_5)$, where R_b is the base resistance of TR2. The capacitor C_3 modifies the square wave output to give a sawtooth function. The modulator coil L_3 is placed in series with the collector load resistor, R_6.

The self-contained power supply in the package comprises 14 mercury "B" battery cells, specially packaged for high resistance to shock. These cells have an emf of 1.34 volts each, giving a total supply voltage of 16.5 volts. The total drain for the entire package varies between 4 and 5 mA. Since the cells have a life of 130 mAH, the supply has a life of 25 hours which is sufficient for several firings as well as pre-flight experimental testing.

The transmitter package fits into an opening 2 inches in diameter and 3 inches long. The circuitry is contained on two cards 1.8 inch in diameter and the battery is in a block 1.6 inch diameter and .6 inch deep. The package could be made considerably smaller if the necessity arose.

The cards containing the circuitry are held in slots in an aluminum container and are of a glass melamine

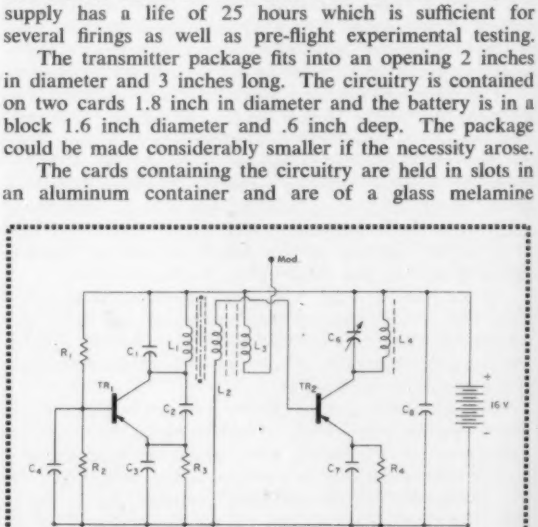


Fig. 3 Colpitt's circuit transistor oscillator

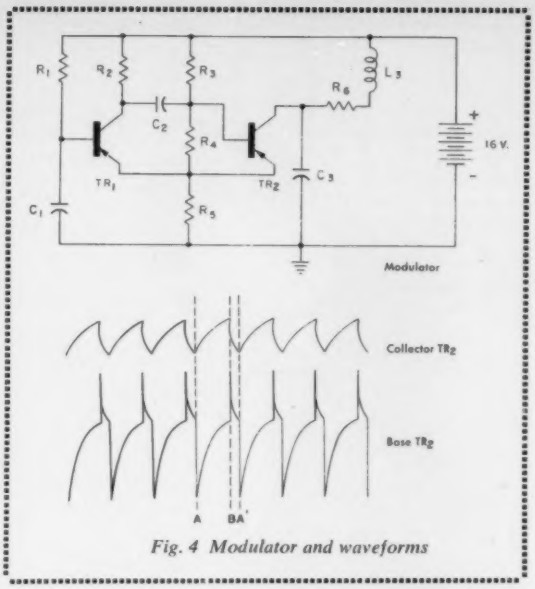


Fig. 4 Modulator and waveforms

material. (fig. 5) The container is split in half down the length to facilitate removal and installation of components. These halves are held together by two caps which fit on the ends of the container. The components are laid flat on the cards to distribute the load over as wide an area as possible. On the prototype models, point-to-point wiring was used instead of printed circuitry which would have been more satisfactory from the weight factor, but more expensive to fabricate. The package is switched-on and connected to the antenna by means of a four-pin connector on one end of the package. This plugs into a socket inside the missile which has two pins interconnected to provide a connection from the battery to the oscillator and two connected to the antenna coil.

By use of a special packaging technique three transmitters may be included in each package to record three components of lateral acceleration, or whichever choice of information is desired from the model to be tested. Thus, one model could be used to give acceleration information and another to give surface temperatures. Angle of attack information may be obtained by use of pressure differential measurements or calculated from the acceleration components. Special transducers capable of withstanding the initial shock will be required and these will have to be developed as the requirement becomes defined. The accelerometers for use in the package must be of an extremely small size and very rugged construction. They will be used to modulate the oscillator directly and a variable inductance type is proposed. Special packaging will ensure its recoverability.

Problems of the f-m system

A frequency-modulation system has several limitations when more than one signal from the transmitter is desired. The effect of amplitude modulation on the oscillator output cannot be completely eliminated from the discriminated output and due to the short time during which the signal is transmitted during the flight of the missile down the range, there is a severe requirement imposed on the limiter response of the receiver.

The possibilities of the technique may be illustrated by its application in obtaining three signals simultaneously from the projectile transmitter. A transmitter employing one to three sub-carrier oscillators is frequency modulated by the vehicle transducers. These sub-carrier oscillators then amplitude-modulate a high frequency carrier oscillator and the resultant is radiated from the ferrite antenna in the missile. The equation for the current through the antenna coil due to this modulated carrier employing only one sub-carrier oscillator is:

$$i = I_m \sin w_c t + \frac{mI_m}{2} \cos (w_c t - w_s t - \sin w_m t) - \frac{mI_m}{2} \cos (w_c t + w_s t + \sin w_m t)$$

where:

I_m = peak carrier current
w_c = carrier frequency
w_s = sub-carrier oscillator frequency
w_m = instrument modulation frequency
m = carrier modulation intensity.

This can be seen to be composed of three main frequency components:

(a) the carrier frequency
(b) the lower sideband ($f_c - f_m$) and
(c) the upper side band ($f_c + f_m$).

For each sub-carrier frequency, there will be a corresponding pair of carrier sideband frequencies.

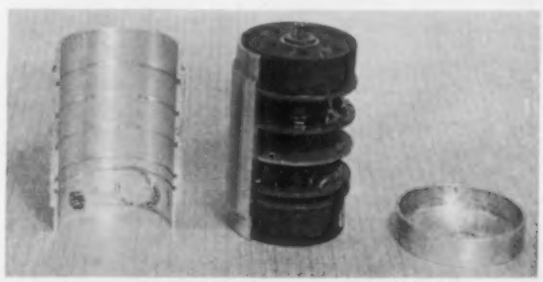
A receiver may be designed to detect the carrier and lower sideband frequencies. The carrier is passed through a narrow band filter and used to convert the sidebands to their original sub-carrier frequencies. These are then demodulated in separate filter and discriminator channels to obtain the original vehicle transducer signals. By this method, drifting of the carrier due to temperature or environmental effects is cancelled out in the receiver and the telemetry information can be detected with a higher degree of accuracy. This telemetry method may be extended for certain applications in larger or full-size models. The use of transistorized circuitry and subminiature accelerometers for accurate measurements results in the size of the telemetry package being considerably reduced, leaving space for other channels of information which otherwise could not be included due to space limitations.

Conclusions

Development to date has confirmed the feasibility of installing a telemetry transmitter within a small projectile to enable aerodynamic information of its supersonic flight to be recorded instantaneously . Accurate results from a flight can thus be recorded and made available with negligible data reduction a short time after its completion. The usefulness of the facilities available in an aero-ballistic range may be greatly increased by the use of such a radio-telemetry link.

The former tedious and time-consuming indirect methods of measurement may be superseded by this more direct and rapid method of measurement of aero-dynamic data. This system can also be used to great advantage in guided missile telemetry, due to its inherent advantages of small space, light weight and low power consumption.

END



Aluminum cover removed to show transmitter

Successful management stimulates professional growth

P. HUMENIUK, P.ENG.*

The proper type of management produces a climate that is conducive to the development of men. Men are challenged to develop themselves and by so doing, promote the growth of management itself. The orthodox concept of a manager as a dynamic, cigar-smoking, dominating person no longer holds good, although he must still be a leader.

Our contemporary economist Peter Drucker has said: "We need to make more effective use of the one and only real resource we have, the creative imagination, the systematic knowledge and the freely given responsibility of the human being. Our real capital is not money. It is not raw material. It is not machines. The real capital is the human mind and the human heart."

In this quotation Peter Drucker states very aptly that our real resource is people and in particular their creative imagination and systematic knowledge. This creative imagination and systematic knowledge is the essential difference between a "professional" and a non-professional employee in industry. The non-professional employee works in a job somebody else has laid out. The professional on the other hand applies creative imagination and systematic knowledge to perform his work better than it was ever done before. In addition he seeks to advance the knowledge of his vocation. He becomes an authority in his field.

It is not formal schooling or an academic degree that makes the professional. The old saying of the physicians

*Canadian General Electric Company Ltd., Toronto

applies to every professional no matter what his field. This saying is that "a medical degree does not make a man a doctor. All it does is give him a license to kill without being put into jail. Only he can make a doctor of himself who can make himself capable of curing people." Similarly he is a professional only if he makes a professional out of himself regardless of whether he is working as an engineer, a lawyer, an accountant, statistician, salesman, production planner, personnel expert or a buyer.

Now that I have defined what I mean by professional I would like to delve into the kind of management which stimulates this professional growth. But first I would like to point out that over the past century management has emerged as a distinct profession and a science with identifiable principles. Hence the approach which I shall use is to identify some essential principles which are concerned with the stimulation of professional growth. It is important for both the manager and other professional employees to understand these principles.

Basic principles

The first principle is that the process of professional growth is essentially the process of self-development of the man himself. This principle places the prime responsibility for professional growth on the man himself. No outside influence can substitute for inner drive and initiative. The manager, however, can influence this self-development process significantly by increasing self-development opportunities and removing obstacles to growth.

The second principle is that the manager can influence professional growth most effectively on the job. This principle stems from the idea that learning by doing is more important and more effective than learning by study and by educational courses. Study and training are very important indeed and must be pursued. However, the most effective method to develop a man is to put him on a job with real responsibility and authority and insist that he carry it through himself. A man cannot learn how to swim from educational courses without getting into the water and getting wet.

The third principle is an extension of the second, namely that the manager can influence self-development most effectively by giving the man real responsibility and authority in his job. This delegation of responsibility and authority is by far the most powerful and essential force to stimulate professional growth. This principle has been widely quoted and generally accepted and yet, strangely enough, it is rarely practiced. There are two basic reasons why proper delegation is not practiced.

The first is that many managers do not have a genuine belief in delegation. Some managers feel that they cannot carry out their responsibilities by delegating work to others. Yet, strangely these same managers feel that real authority should be delegated down to them. In many cases, the more competent the manager in any functional field, the more difficult it is for him to delegate to others. He recognizes that he can do the work better than his man, so why pass it on to him?

The second reason is that many managers do not properly understand the principle of delegation. They may pay lip service to it but they do not delegate because they do not know how.

The art of delegation

In order to delegate properly, the manager must clearly define the job, preferably in writing. He should clearly state the man's direct responsibilities and authorities. He should clearly define the limitations of the man's authority, preferably in such a manner that the man can see the limitations in terms of a perimeter. Within this perimeter, the manager allows the man freedom of action. The larger this perimeter, the greater is the opportunity for freedom of action, initiative and hence opportunity for professional growth.

Able managers practice this delegation of authority in a clean-cut and consistent manner. Consistency is very important. If the manager gives the ball to this man, then he should not take it back on the least provocation. Such action leads only to confusion.

Within this perimeter of freedom of action the manager must give the man a free hand to work out his own solutions in his own way. He should be free to make his own decisions without checking with his manager. He should be allowed the freedom to fail. A man learns best from his mistakes. When a man is free to fail, he is put at risk. When at risk he toughens and performs better.

The manager must fight off the urge to get into the act no matter how hard the going is. He should not become exasperated and try to do the job himself as the easiest way out but rather should give guidance and encouragement and insist on a high standard of performance.

There are men who are reluctant to accept authority and have a tendency of coming to their manager for decisions. It takes courage to make decisions. The manager must force the man to make decisions on his own and at the least to come to him with recommendations rather than with problems. If a man makes a series of successful recommendations each of which is confirmed by his boss, he builds confidence and judgment, and learns to make decisions entirely on his own.

A manager should maintain control by measuring the progress of the work and not the details of how the work is being done. There is a strong tendency for the manager who is skilled in a particular function to spot and correct small details which do not meet his standards of perfection. Unless he has unusual self-discipline and control, about the only way he can avoid correcting minor details is to avoid them. The manager should develop the habit of keeping his eye closely upon the operating results only.

This principle of delegation is the most important characteristic of the job in providing opportunities for professional growth. The manager who delegates properly, even though he may be disliked personally, is likely to promote greater professional growth than the manager who possesses other fine qualities and is liked personally but lacks delegating skill.

Job must challenge ability

Another important characteristic of a job in providing opportunity for professional growth is that the job must challenge and stretch the man's ability. This I consider to be principle number four. The manager must set high standards of workmanship and integrity. In addition the manager should include in these standards the requirement to advance the knowledge of his vocation and to make this information available through the medium of publishing his work and taking an active part in professional societies.

Not only should the manager set these high standards but he should motivate his men to attain them. He can do this by various techniques such as creating a competitive spirit, appealing to their pride, by displaying confidence in the men, by enhancing the importance of the job, by setting a good example himself, by developing team spirit, and by inspiring his men by his zealous belief, by giving credit and recognition for work well done, by financial incentives and by providing opportunities for promotion.

My principle number five is the manager stimulates professional growth by providing opportunities for involvement or participation along with the freedom of self-expression. By providing opportunities for the man to participate in the manager's problems, in the formulation

of his objectives, goals and over-all plans and programs, the manager provides opportunities for the man to develop a broader understanding of the business and a managerial attitude which is so essential among professional men in industry. This participation should likewise extend into the formulation of the high standards for which the man will be held accountable. In the majority of cases a man will recommend higher standards than the manager would dare to set.

During this participation the man must be able to speak confidently what is on his mind. It is better for the manager to get conflicting points of view out into the open, to permit a successful settlement. A suppression of these conflicts causes internal resentment and ultimate hostility, a major obstacle to self-development.

Review performance

The last principle which I would like to cover is the principle that a manager's frank appraisal of the man's performance influences greatly a man's professional growth. The manager should discuss with the man his performance on his job as often as is necessary. The best climate for professional growth is a combination of sun and storm, the sunshine being the approval and recognition of work well done and the storm being the frank warning that the work is not well done.

In addition to discussing the man's performance with him the manager should explain to the man the opportunities that are available. He should likewise plan with him special assignments on the job which are in line with the individual's desire for new experience in order to equip him better for possible opportunities. It must be clearly understood, however, that promotion is earned only by exceptional performance on the present job.

In order to broaden the man's interests, the manager should encourage him to participate in off-the-job activities such as professional and civic affairs. In addition he should encourage the man to improve his professional growth through the medium of self-appraisal, self-discipline, self-motivation and self-improvement. In effect the manager should place the onus for professional growth directly upon the man himself.

I would like to point out that it is important for the manager to recognize that his own performance and professional growth is determined by the professional growth of the personnel under him. A manager is primarily responsible for securing results through the work of his men. As his men grow and improve, his over-all performance improves.

In summary, the kind of management which stimulates professional growth is the kind that recognizes and practices the following principles:

1. The process of professional growth is essentially the process of self-development of the man himself.
2. The manager can influence professional growth most effectively by providing opportunities in the job itself.
3. The manager can influence professional growth most effectively by giving the man real responsibility and authority in his job.
4. The manager should organize the job in a way which will challenge and stretch the man's ability.
5. The manager stimulates professional growth by providing opportunities for participation along with the freedom of self-expression.
6. The manager influences professional growth by appraising the man's performance and planning with him his self-development.

In fact, this kind of management makes the most effective use of our most precious resource—the creative imagination, systematic knowledge and the freely given responsibility of the human being. END

Aluminum welding easy with low temperature fluxless solder

SAMUEL FREEDMAN*

Welding or soldering of aluminum—an alloy which is finding increasing application in electronics work — has been a difficult procedure requiring specialized knowledge and the use of corrosive fluxes. A low temperature fluxless solder has been developed which allows welding and soldering of aluminum. Temperature required is only 500 deg F.

The use of aluminum has grown because it is plentiful, low in cost, light in weight, rustproof and attractive. However, it has been a metal difficult to solder or weld because it is covered by a protective oxide film which forms whenever it is exposed to air. This film will not disintegrate at temperatures less than the melting point of aluminum itself (1218 deg. F.). Unless this film can be penetrated, soldering (adhesion) or welding (fusion) is impossible.

In the electrical, electronic, aeronautical and allied fields, the uses for aluminum are many. For vehicles or missiles in flight, hand or human-carried equipment, there is a need to solder or weld materials made of aluminum. Sometimes, it is necessary to join aluminum to other metals. Examples include cabinets, chassis, panels, frameworks, shielding, antennas, reflectors, waveguides, flanging, pressure-tight and liquid-tight housings, leakproof and gasproof containers and conditioners where rust or corrosion cannot be tolerated.

Fig. 1 shows the most serious problem in trying to soft-solder to aluminum. Left, soft solder applied to heated aluminum "balls" up and rolls off instead of adhering. Right, the same aluminum has been tinned with Chemalloy's fluxless aluminum solder. Soft solder will readily adhere to it and permit the attachment of any metal that can itself be soft-soldered.

The ability to cleanse and homogenize normally incompatible zinc and lead metal blends by the indirect introduction of muriatic acid while in initial molten state, results in a joining material that requires no flux, and is electrically balanced to reduce corrosion. Requiring only 40% of the aluminum damage temperature, it protects the parent metal during the heat-up process. Its electrically balanced property also gives it dry bearing abilities to withstand friction without coolant or lubrication.

*Chemalloy Electronics Corporation, Santee, California.

Fig 1 Soft solder (left) rolls off aluminum. Right, Chemalloy fluxless aluminum solder allows easy soldering.

This fluxless soft solder and welding rod eliminates the need for special metal cleaning or surface scratching. Fluxes potent enough to dissolve the oxide and expose the bare parent metal are not needed. Such fluxes normally contain chlorides and fluorides which if not completely removed following soldering or welding, will attack or corrode the base metal when exposed to moisture.

Sixteen Problems

In connection with the soldering of aluminum waveguides and direct attachment of soldered grounds to aluminum, we faced and solved 16 problems:

1 Fluxless; 2 Low application temperature and melting point; 3 Reduction of skill required; 4 Use of elementary facilities; 5 Welding to be as simple and no more damaging than soldering; 6 Ability to bond other metals to aluminum; 7 Ability to work with very thin gauge aluminum without burnup; 8 Ability to withstand friction, chafing and immersion including sea water and salt spray; 9 Noncorrosive and avoid galvanic action due to unidirectional or electrical balance effects; 10 Meltable and reusable with correction of mistakes; 11 Ability to adhere to zinc, potmetals, etc.; 12 Function with platings or coatings of aluminum or zinc as well as solid compositions of them; 13 Utilize any heat source; 14 Able to machine, polish and plate; 15 Be safe to use; 16 Be as strong as or stronger than metal.

Table I shows various blends which have yielded fluxless aluminum solder or welding rod requiring application temperatures between 500 and 800 degrees fahrenheit. On a research basis, work is continuing on dropping the minimum temperature 100 to 150 degrees so that soldering irons can be used.

The successful blends have been those which were high in zinc and contained up to several per cent of lead. However, zinc and lead are normally unblendable because the lead sinks to the bottom and separates the grains of zinc, causing powderization. Steps were taken to not only blend but to also homogenize and cleanse the ingredient metals.

Addition of Muriatic Acid

This was accomplished by adding a small quantity of muriatic acid with the metals in a molten state. In order to prevent any risk of explosion, a special super-porous flour-like material with many pores per grain was developed. It was impregnated with muriatic acid to a paste consistency.

TABLE 1. EXAMPLES OF BLENDS USED IN FLUXLESS ALUMINUM SOLDER

VERSION	ZINC	LEAD	TIN	ALUMINUM	COPPER	TENSILE STRENGTH
500°F.	90%	7%	3%	—	—	10,000 psi plus
600°F.	87%	5%	3%	5%	—	25,000 psi
800°F.	85%	1½%	½%	8%	5%	50,000 psi

Fig. 2 Pouring from crucible to solder forming tray

This is introduced into the molten metal with special techniques, sequences, quantities and intervals plus minor control additives. The result is one miniature reaction for each pore of each grain of the carrier material. What would otherwise become a single instantaneous explosion, is safely converted into a multi-minute prolonged boiling and agitation of the molten metal. Its intensity is fully controllable. The object is to cause optimum homogenization of zinc, lead and other metals, and to lift up nonferrous residues and impurities to the surface.

The superfluous material floated to the surface is then skimmed off. This includes all the carrier material which becomes buoyant and porous after the muriatic acid has been consumed. There is no evidence of the muriatic acid remaining in the metal. Fig. 2 shows a ladle of this cleansed and homogenized metal being poured into a welding rod forming tray.

The metal now has three properties. As shown in Fig. 3, it can solder to aluminum without cleaning and without flux. It is merely necessary to heat up the aluminum hot enough for the rod to melt on contact. It is a dry bearing metal requiring no lubrication and resisting heat buildup. As shown in Fig. 4, the metal yields a characteristic electrical potential and current when in contact with liquid.

If the metal is machined, the lathe cuttings always powderize. These powder grains in liquid will be found to register both positive and negative polarity as one meter lead in the solution is moved with respect to the other. Being in electrical balance, the product is noncorrosive and nongalvanic so far as the material itself is concerned.

The metal when put in liquid attacks the liquid and decomposes it into hydrogen. Bubbles of gas rise to the surface where they may be exploded with a lighted match. The metal attacks the liquid and the liquid consumes itself. As the liquid evaporates, the metal becomes electrically inert but immediately goes back to normal electrical indication once more liquid is added. The typical potential plus and minus is .5 volt d-c for fresh water dropping to as low as zero for petroleum and increasing to as high as 1.1 for potent chili sauce liquids. It is the number of metal pieces rather than their size which indicates appreciable response electrically. The largest metal piece and the smallest grain yield the same electrical response.

Application temperature 500 deg. F.

By the above process and technique, every one of the 16 details mentioned is satisfactorily resolved. The solder is fluxless with no corrosive remnants in the joined aluminum. It has a melting and application temperature as low as 500 deg. F. This is less than 40% of the melting point of aluminum and ensures minimum damage to the parent metal. Soldering and welding are similar and accomplished with the same product, skill and facilities. The difference between soldering and welding is merely heat prolongation. Heat intensification plays no part and should not be employed. As heat is first applied hot enough for chemalloy to melt on contact, it is soldering (adhesion). As the heat is continued under the same circumstances, capillary action takes place and the solder travels through the oxide and under the skin of the aluminum. This is visible as the darker fringe area of the rectangular aluminum tinning in fig. 1.

In practice, this is manifested as a horizontal movement on sheet aluminum rather than a vertical movement which would burn through the aluminum in its thinnest dimension. Heat will naturally move in the direction of maximum heat which is the direction of maximum mass. This ideal circumstance spares the parent metal from damage. A novice heating for too long would merely have improved welding or fusion over a greater area.

Facilities are elementary. The best heat source may be a small prepo or bernzomatic torch. Oxyacetylene is normally excessive but may be used if the heat is retarded. Soldering irons may be used if they furnish sufficient heat not only to melt the 500 degree solder but to offset the heat conductivity of aluminum which tends to bring down the effective soldering iron temperature to less than the level needed. Soldering irons should not be too needle-pointed as area heat is preferable. If no special heat sources are available, results can be obtained by placing

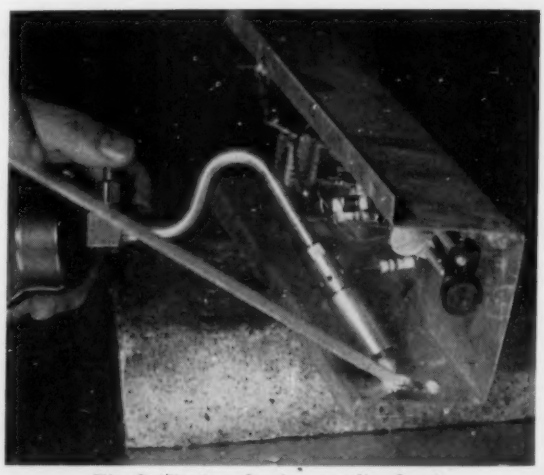


Fig. 3 Tinning aluminum radio chassis

the aluminum on a hot plate, gas burner, or electric range heater unit until it becomes hot enough for the solder to melt on contact.

Copper and any metal which can take soft-solder may be joined to aluminum with this material. This is best done by tinning the copper with soft solder, and the aluminum with chemalloy, and then bringing them together. To join thin gauge or foils to thicker pieces, takes skill. Both pieces should have the same amount of heat per unit mass area, otherwise one will receive more soldering or fusion than the other.

Salt spray tests

Friction and chafing pose no problem as the metal has dry bearing properties. Salt spray tests of 20% up to 2,000 hours have taken place. After about 200 hours, a protective coating forms, following which, continued exposure becomes meaningless. In order to markedly disturb the product, it is necessary to upset its inherent electrical balance with a substantial and prolonged unidirectional current. Anodizing is capable of creating such an electrical upset if prolonged. It is therefore advisable to use aluminum protective measures other than anodizing or none at all to prevent corrosion due to such process.

The material has never splattered or exploded and has shown no hazard in use. Laboratory tests have verified this in thousands of trials and tests since 1951.

Fig. 5 shows a magnified cross-section view of the 500 degree chemalloy fluxless solder version as bonded to aluminum. The left view shows magnification of 70 times. The right view 350 times. The same major aircraft firm where this test and photograph were made has verified that the strongest aluminum (75S rated at 76,000 psi) will part first in destruction tests. Although this is more than manufacturer's recommended rating for tensile strength, it has this excess strength property when the parent metal is of a type that contains zinc in its composition. In the case of 75S, the aluminum composition includes 5% zinc. Whenever zinc is present in parent aluminum, there is normally a great excess of strength for the joining material with respect to the metal it joins.

The techniques by which this joining material is derived can undoubtedly be used to improve other metals or metal blends so as to yield special properties. Its bearing properties, where it operates heatlessly and lubelessly for appreciable periods of time seem to be due to microscopic space-separated electrical friction rather than direct full metallic contact. The bi-polar electrical properties, dry bearing properties, and ability to penetrate surface oxides without flux appear to be inter-related.

Fig. 4 An electrical potential of either polarity exists between the solder granules and liquid as shown on meter

New research uses for this product include better contact materials for runners of supersonic sleds, as a skin for space vehicles and guided missiles for the purpose of resisting space friction heat buildup etc. It also holds high promise as a substitute for tin in babbitt metal applications. Its eventual price, with sufficient increase in acceptance, is expected to be very close to that of bulk aluminum itself per pound. END

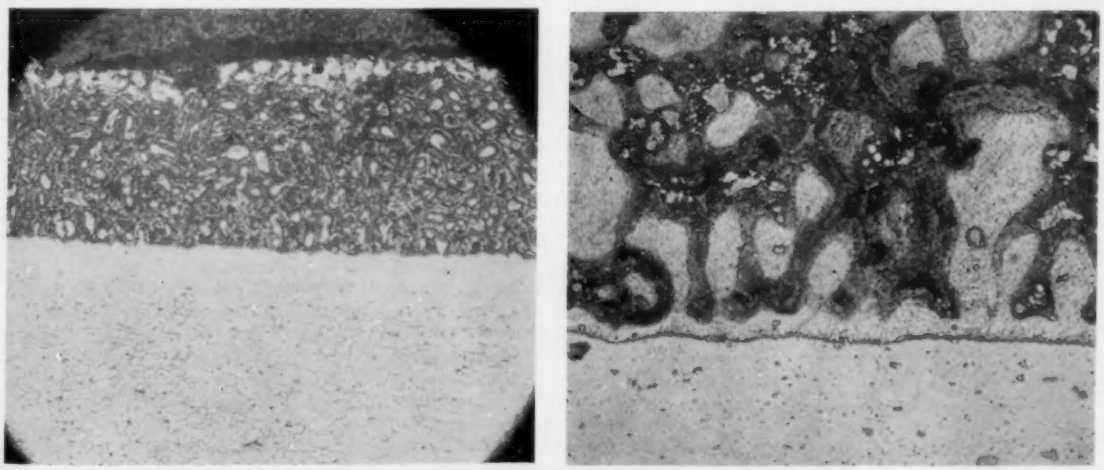
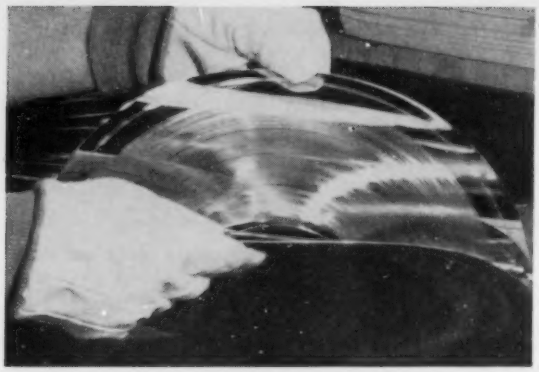


Fig. 5 Cross-sections of the solder magnified 70x (left) and 350x (right)



Improvements are constantly being made in the techniques of sound recording and of producing phonograph records. The frequency response of records today covers the range of human hearing and the job of producing high quality records is becoming more complex. This article describes electronic and mechanical recording techniques.

Audio forum

Latest recording techniques improve quality and frequency range

KENNETH W. LINES, MANAGING EDITOR

Just 70 years ago Emile Berliner developed a flat disc record with a laterally undulating groove. This was the beginning of the record making industry as we know it today. One of the earliest commercial records produced by Berliner was "The Holy City" sung by the Haydn Quartet and the label was stamped "Improved Berliner gram-o-phone." This was a relatively fine groove record and it came from Berliner's company in Canada, for he had performed most of his research work on lateral recording techniques in Montreal. These early records were nominal 78 rpm but their speed varied between 76 and 82 rpm.

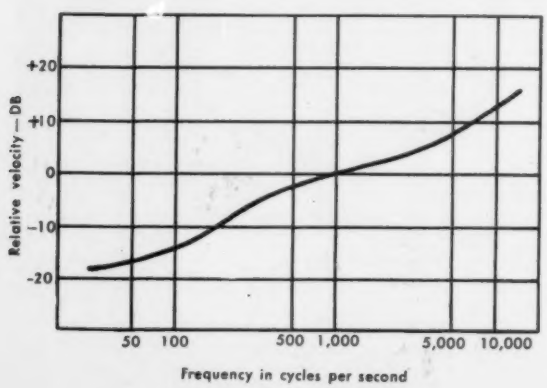


Fig 1 Recording characteristic curve

Records at 78 rpm are today being eclipsed by 45 rpm recordings for the shorter and popular music and long-playing records at 33 1/3 rpm have taken over the field of concert music. The techniques of making long-play recordings have changed considerably even in the last few years. It is now generally agreed among the recording companies that they should follow one characteristic recording curve. This is the RIAA curve which is standardized with the "new Orthophonic" frequency response curve which RCA Victor had been using for some years.

Effect on low and high frequencies

This curve, shown in Fig. 1, is the actual recorded velocity plotted as a function of signal frequency with the input signal voltage to the disc recorder being held constant. Recordings are made with the low frequencies reduced in velocity in order to limit the lateral groove excursions and make more efficient use of the space on the record. At the other end of the range the high frequencies are increased in velocity. When reproduced the low frequencies are restored to their original volume by the amplifier characteristics. The reduction of the high frequency response in the amplifier, reproducing the high frequencies at their original volume relative to the low frequencies, means that there is a considerable reduction in surface noise coming from the record. The increase of high frequency velocity is, of course, possible in recording since these frequencies in

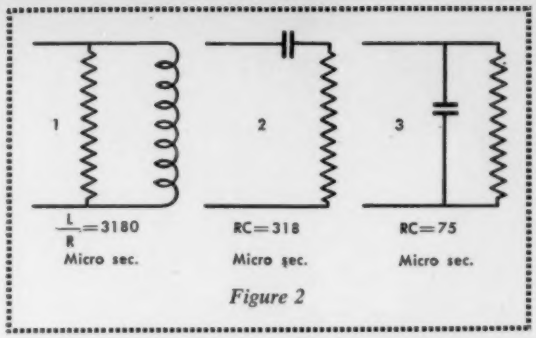


Figure 2

music and speech are normally weaker than the lower frequencies and are based on the energy distribution in the sound spectrum. In addition to this high frequency boost an extra boost is added during the recording on the disc to compensate for loss due to reduced groove speed as the recording comes closer to the centre of the record.

The recording characteristic can be expressed as the algebraic sum of the ordinates of three individual curves which can form into the admittances of the following networks (Fig. 2) expressed in db. These curves are (1) 3db low frequency boost at 50 cycles, (2) 500-cycle crossover and (3) 13.6 db high frequency pre-emphasis at 10,000 cycles.

Automatic variable pitch

Recordings are now made with automatic variable pitch equipment. With fixed pitch there is constant width of "land" — the minimum area between the groove cuts beyond which it is not permissible without the danger of breakthrough between adjacent grooves. Fixed pitch will therefore determine the largest amplitude that can be played on the recording.

With large amplitude sounds taking up the maximum width of the groove there will still be a large amount of time on the recording during which only a part of the available space will be utilized because the maximum amplitude is not being recorded. The variable pitch operation makes it possible to vary the width of the land between the grooves in such a way that this space is not wasted. It also improves the recording in a combination of three ways: (1) longer playing time (2) higher recording level and (3) larger dynamic range. Recordings of 35 minutes playing time on a 12 inch LP have been made, although this is more than can normally be achieved.

Fig. 3 is a diagrammatic representation of the way in which the variable pitch equipment operates. In the diagram there are two recording heads on a tape recorder, the upper of which is the normal playback head, the lower is picking up the same signal approximately two seconds in advance. The lower head feeds the signal to the control unit which computes the combination of level and frequency at which the signal is occurring. The lower the frequencies, and this means in general, also the louder the volume, the larger is the amplitude. The resulting voltage is applied to a servo amplifier which in turn sets the pitch with the help of the servo motor and sensing potentiometer on the lathe screws driving the recording head.

The two seconds advance is chosen to give the variable pitch mechanism time to change for sudden and large level variances and provide adequate land between the groove to be recorded and the already recorded groove. When the high level signal disappears, the control unit delays the closing of the lines so the next recorded groove will not touch the adjacent high level groove. This delay of about two seconds is the approximate time for one revolution of the record.

A normal recording is at the rate of about 250 lines to the inch, with variable pitch the number of lines can range from 180 to 400 lines per inch.

Today most of the recordings are made originally on tape running at 15 in. per second. This allows greater flexibility of recording technique and means that with standard laid down characteristics, tapes can be recorded quickly and in any location in the world and then sent back to a central plant for the remainder of the recording work to be done.

Those recording processes are shown in the following pictures.

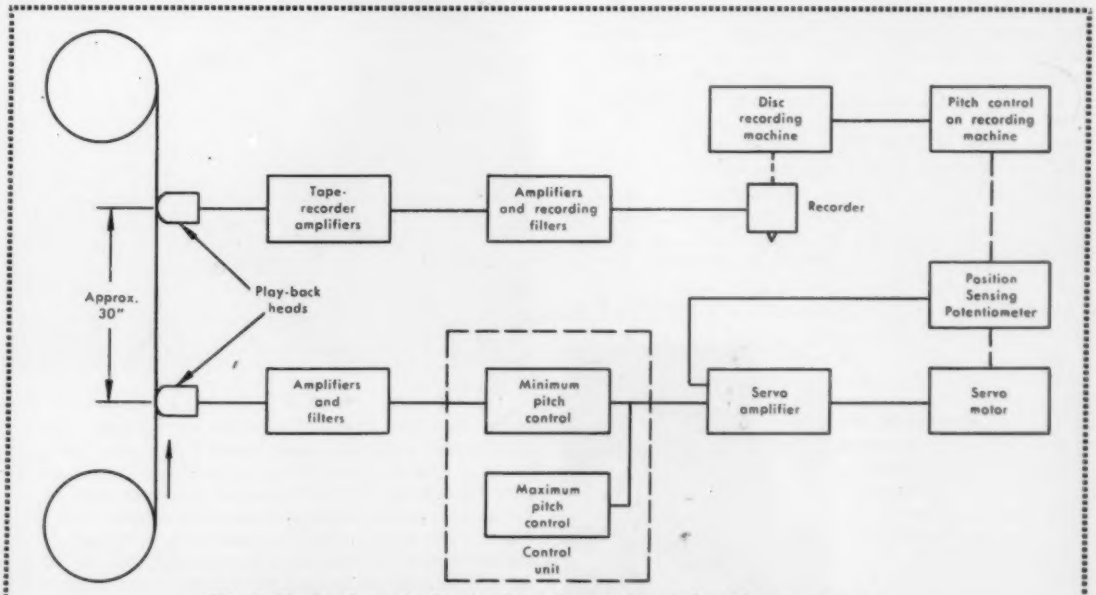
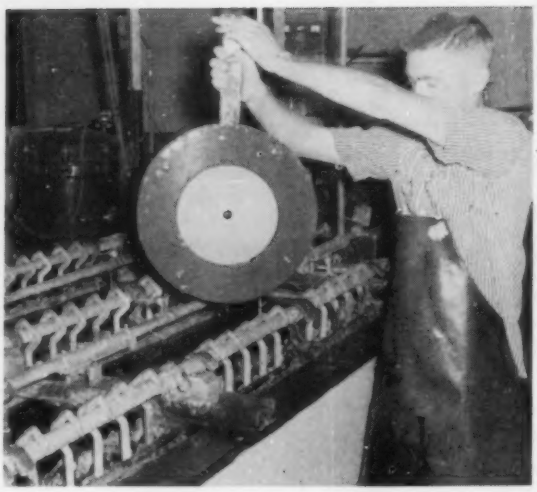


Fig. 3. Block schematic showing how the variable pitch equipment operates

Master record cut from tape

Another view of the recording equipment. The variable pitch control unit is in the background. Unit is fed from a play-back head which picks up signal two seconds before the normal play-back head

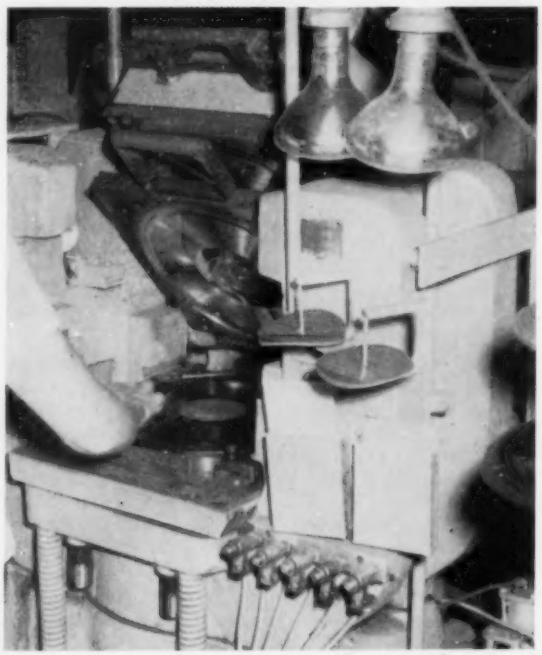
(1) The tape is recorded on to a lacquer master disc. Signals from the tape amplifier energize the recorder head. Cutting is done by a "hot" stylus which is driven from the outer edge of the master lacquer disc toward the centre at a speed determined by the lathe turret which in turn is controlled by the variable pitch unit. The lacquer discs themselves are specially manufactured to a close tolerance thickness and are held perfectly flat on the recording turntable by means of suction tubes underneath. Air suction also takes away the cutting thread made by the stylus. One of the limitations of the amount that can be got onto a 12-in. disc is the fact that the groove should not be moving past the reproducer head at less than approximately 10 in. a second otherwise distortion will increase at a high rate. About the minimum diameter that can be safely got down to at the centre of the record is 6¼ in. although records have been taken less than 5 in. diameter.



Constant checks are kept on reproduction quality by operators in sound-proof booths who listen to selected batches of records played back

(2) The lacquer original is washed to remove any dust or oil that may have collected on the surface. Then it is immersed in a silver solution in a flat pan. The container is rocked gently backward and forward causing molecular silver to be precipitated from the solution and fill even the most minute grooves in the lacquer. Next the silvered disc is suspended in a bath and by means of electrolysis covered with a thin layer of nickel which is backed up with 20/1000 of an inch thick electrolytic copper. The metal portion is then separated from the lacquer disc giving the master disc.

(3) A metal mold disc is made from the master by applying coatings of nickel and copper again by electro plating and the two are separated. There is now a disc similar to the lacquer recording and which is played back for checking. From this yet another plate is made — called the stamper — only by applying a coating of nickel 10/1000 in. thick to the surface of the metal mold and separating the two. This final disc is the one that actually presses the record. It is very accurately centred, cut down to size and large centre hole punched. Finally the edge is profiled to form the edge of the record. This stamp is then placed in the record press and records made under a pressure of 2,000 psi.



(4) Two long playing records are produced from each press in a single operation. This involves a centre mold on either side of which are two stampers and top and bottom mold with the opposite sides of each record on them. The operator places a record label on each of the centre pins and then puts a heated "biscuit" into each section of the machine. The biscuit is of vinylite and when the machine, something like a three-decker waffle iron comes down, the process from then on is completely automatic.

Hydraulic pressure of one ton to the square inch causes the material to flow evenly into the grooves of the record, steam circulates through the press for a few seconds giving a temperature of 300 deg. F then is automatically turned off and cold water circulates. This cools and hardens the record and frees the grooves from the ridges of the discs. The press opens, the records are taken off and the flash or excess material around their edges cut off by special machines and the records stacked on a spindle. Each operator on the LP record production line has two machines to look after and can keep these going steadily. The result is that on the LP line records are produced at the rate of one every 18 seconds by each operator.

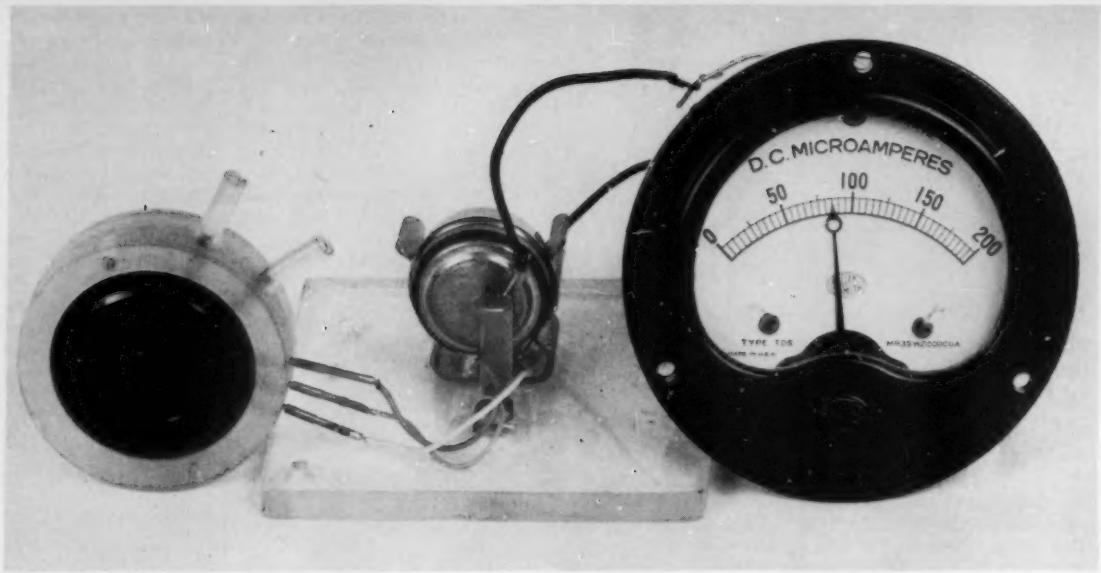
Constant checking is carried out as the records are being produced. Operators sit in sound proofed booths all day listening to records being played back over amplifiers in which the frequency response reproduces the high frequencies at a relatively higher level.

(5) At the end of the line there is also a visual check on all records before they are placed in an envelope and inserted in their particular covers. At the same time one of the other tests being done is the "wear test." In this a record is played automatically scores of times to make certain that the record material in use is up to the required standard of durability and consistency.

Basic materials from which records are made — vinyl plastics — are blended in a giant mixing machine. The mixture is then poured onto rollers that flatten it into sheets. The sheets, riding on a conveyor belt, pass through a set of rotating knives that mark the sheet into biscuits. Each one of these biscuits makes one record.

A 12 in. LP record has up to ½ mile of track on each side. It plays for between 16 and 30 minutes while modern 45 rpms play for up to 8 min. Edison cylinders and the early Berliner laterals averaged two minutes. Today RCA Victor at Smiths Falls are producing about 10,000,000 records of different speeds and sizes every year. This in itself is an amazingly high figure, but think how many miles of recorded sound track have been turned out since Edison's first cylinder wrapped in a sheet of tin foil started spinning. END

Pictures in this article were taken at RCA Victor, Smiths Falls, Ontario.



Solion unit at left is powered by silver-cell dry battery. Designed to activate electrical circuits requiring extreme sensitivity and very low power consumption, the solion consumes 100 to 1,000 times less power than many transistors

Part II: Application of electrochemical principles

Solion devices use ions in solution

R. M. HURD & R. N. LANE*

Solion devices utilizing the movement of ions in solution hold great promise as elements for detecting and metering dc and low frequency ac fluid flow, electrical signals and mechanical motion. Part II describes the principles used in the various applications

The new technology of chemtronics was brought to the attention of the public when the U. S. Navy Ordnance Laboratory, White Oak, Md., turned over to private industry the technical information on the solion. This is an electrochemical device involving the movement of ions in solution.

The principal advantage of these new devices lies in their very low power consumption; much less, for example, than that required to operate a comparable transistor system. Other advantages are inherent stability, long life, ease of manufacture, and simplicity of operation. Their principal disadvantage is the limited frequency range over which they are operable, presently lying between 0 and 200 cps.

The component parts of these new systems vary widely in the type of function performed; there are, for example, elements for detecting and metering both d-c and a-c fluid flows, or d-c and low frequency a-c electrical signals; units for taking logarithms, derivatives, and products of electrical and/or fluid flow inputs; units for integrating pressures, flows or electrical signals over short intervals of time, etc. The operation of all these units is based upon fundamental and well-known electrochemical phenomena, so they may be referred to as electrochemical units.

As far as is known, at Defense Research Laboratory and Naval Ordnance Laboratory, the idea of using an electrolytic cell for acoustic detection was first proposed in 1941 by D. S. Muzzey, presently of NOL, who was working at that time at the Geophysical Laboratory of the Shell Oil Company. Very early detectors which worked after a fashion were tried at that Laboratory, and then offered to the Navy. Various models were constructed at NOL between 1942 and 1944, but the program was dropped because of the variability between units. At present enough research has been carried out to understand the reasons for variability between units and to be able to control the characteristics of the units.

Use of concentration polarization for flow detection

A typical flow detector is shown in fig. 1. Electrodes may be of any metal which is inert to the electrolytic system used. In this particular example platinum electrodes are used in an electrolytic system of iodine and potassium iodide in water. The cathodic reduction of iodine is made the controlling reaction by using a low concentration of iodine (10^{-2}N) and a high KI (supporting electrolyte) concentration (0.5 n).

*Defense Research Laboratory, University of Texas.

The Solion papers Parts I & II were made available through the Technical Information Division, United States Naval Ordnance Laboratory, Silver Springs, Maryland.

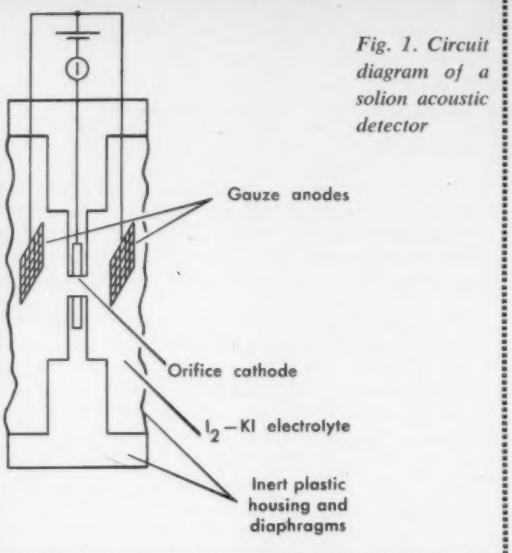


Fig. 1. Circuit diagram of a solion acoustic detector

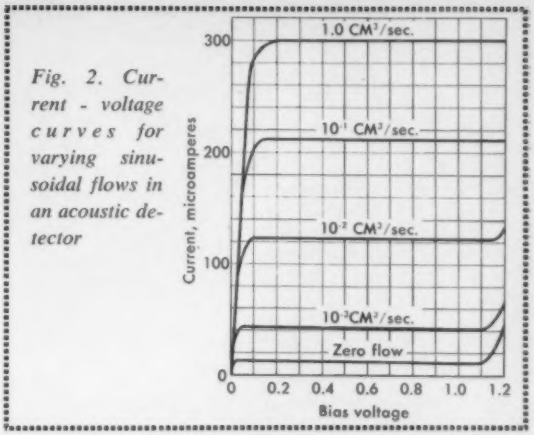


Fig. 2. Current - voltage curves for varying sinusoidal flows in an acoustic detector

At the electrodes the following reactions occur:

(1) at the cathode $I_3^- + 2e \rightleftarrows 3I^-$

(2) at the anode $3I^- \rightleftarrows I_3^- + 2e$

The current in the system is evidently controlled by the number of I_3^- ions which come into contact with the cathode. When there is no electrolyte flow through the cathode orifice, the current is controlled by diffusion; fluid flow of the electrolyte increases the number of available I_3^- ions at the cathode and the current in the system increases. It should be noted that the reactions within the detector are reversible and there is no depletion of the unit during the chemical processes. Other electrolyte systems may be used, as, for example, ferricyanide-ferrocyanide, bromine-bromide, cericcerous, ferric-ferrous, etc. It is only necessary that they be reversible redox systems.

Current voltage curves for a cell of this type are shown in fig. 2 for different values of low frequency acoustic energy incident on the diaphragms. A plot of the equilibrium current as a function of the incident pressure is given in fig. 3. The relationship between current and pressure is expressed by equations of the type:

$$I = k\,P^n \text{ or } I = k \log P,$$

with the values of n and k dependent on the geometry of the cathode.

Fig. 4 shows the type of response which may be obtained from a detector system with an electrode geometry which yields a logarithmic current output with respect to acceleration of the electrolyte. A range of three decades in acceleration is achieved by a very simple instrument consisting of an electrochemical detector, a battery, and a microammeter. The units used for obtaining the data shown in fig. 4 were similar to those shown in the photograph. Note that no switches or other controls are used to cover the three decades of acceleration from 1 cm/sec² to 10,000 cm/sec²; the acceleration may be calibrated directly on the meter face.

The unit was tuned to resonate at 30 cps as shown in the frequency response curve of fig. 5, but these units actually have their best response below 30 cycles down to d-c. Particularly good results may be obtained between 2 cps and 10 cps.

From an electrochemical standpoint, the proper operation of these units requires the following:

1. As nearly reversible electrode reactions as possible so that no energy is consumed in overcoming activation polarization.
2. Equal and opposite reactions occurring at the anode and cathode; i.e., a redox system, so that no net changes in concentration take place as current flows through the cell.
3. Absence of reducible or oxidizable impurities. A

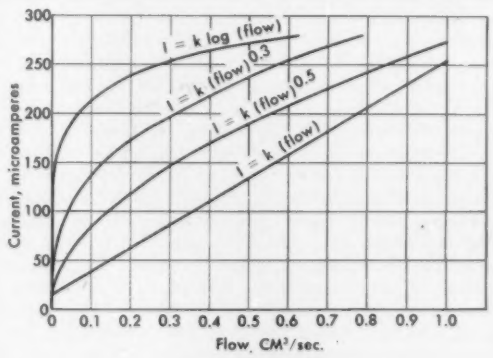


Fig. 3. Typical current-flow curves derived from solion acoustic detectors having different orifice designs

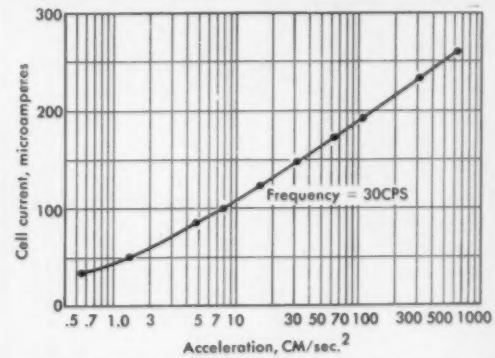


Fig. 4. Calibration of electrolytic cell as an accelerometer. Motion was applied along cylindrical symmetry axis

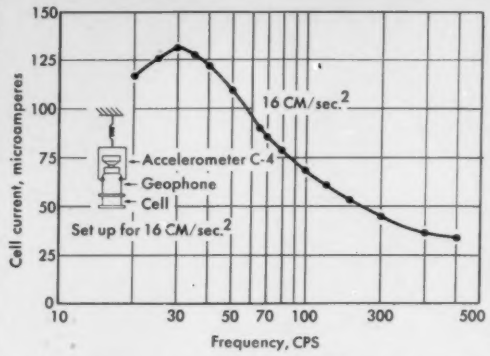


Fig. 5. Frequency response of an electrolytic cell as an accelerometer. Motion along cylindrical symmetry axis

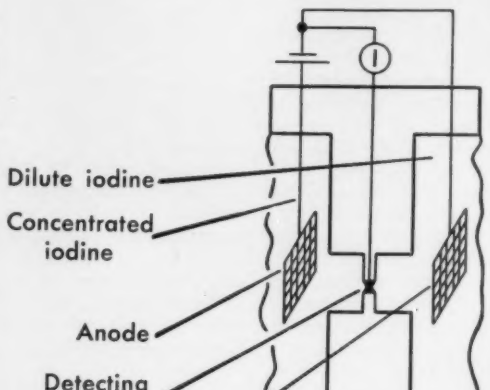


Fig. 6. Schematic diagram of a separated detector type cell for measuring dc flows and pressures

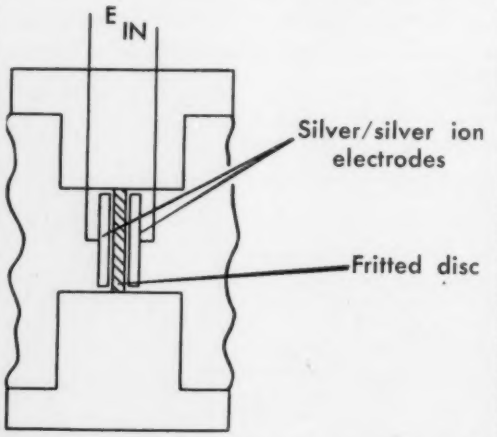


Fig. 7. Schematic diagram of an electro-osmotic cell which converts electrical signals to fluid flows

reducible impurity not only yields a momentarily higher current, but builds up a permanent higher concentration of the primary reducible reactant (in this example, iodine) by the increased anodic oxidation.

The separated detector for d-c measurements

The cell described above was designed primarily for detection and metering of acoustic energy (a-c pressures). A more satisfactory design for d-c flows and pressures is shown in fig. 6. In this cell an additional cathode is placed in the right-hand compartment so that the bias voltage transfers the iodine from this side to the anode side, resulting in a final concentration of virtually zero in the cathode side.

The working cathode consists of a small piece of closely woven platinum gauze situated in an orifice between the two compartments. Flow from left to right (concentrated to dilute) produces an electrical signal directly proportional to the magnitude of the flow. For a detector operating linearly, i.e. reducing all the iodine in the fluid flowing through the gauze, the current output is given by the equation:

$$I = 10^{-5} FN \frac{dv}{dt}$$

where F = the Faraday
N = normality of the reducible substance on the anode side
$\frac{dv}{dt}$ = flow rate in cm^3/sec

From this equation, assuming iodine normality of 10^{-1}, it can be seen that flow rates as low as 10^{-5} cm^3/sec yield currents in the neighborhood of 100 microamperes, or some ten times the no-flow current. Experiments have shown that, by suitable design of the detecting cathode, linear current outputs are obtainable over a range of four orders of magnitude in the flow rates.

Note that the unit shown in fig. 6 is also a rectifier in that fluid flow from right to left will not produce a current, since no iodine is carried over the detector gauze. A full-wave detector may easily be constructed by using two anode compartments and two detector gauzes.

Conversion of electrical energy to fluid flow

In order to perform various mathematical operations upon the output currents of the devices described above, it is necessary to have a unit which carries out the reverse operation of converting these very low power electrical signals into fluid flows. In this manner, electrical and fluid flow signals may be fed from unit to unit in much the same manner that currents and voltages are fed through electronic networks. In addition to simple amplification, several mathematical operations may be carried out upon the original incident signal or signals in this manner; for example, products, ratios, derivatives, etc., may be obtained.

The simplest and most reliable method of carrying out this reverse effect is by the use of electro-osmosis. An electro-osmotic cell (fig. 7) consists of a fritted glass disc dividing a cell into two compartments, with electrodes on each face of the disc. The operating characteristics of such a cell can be made to vary over extremely wide ranges by control of such variables as disc porosity, thickness, and diameter, and choice of working liquid. The important point, however, is that the fluid flow produced by an applied voltage is linear with the value of voltage. If the flow is restrained, as, for example, by means of the plastic diaphragms of fig. 7, then the electro-osmotic pressure developed is linear with the voltage. In fig. 8 the equilibrium pressures for a typical "fine" porosity fisc (about 4.0

microns pore diameter) is shown plotted as a function of applied voltage, using distilled water as the working fluid. Unrestrained fluid flow for a 30 mm diameter, 20 mm thick disc of this type is in the neighborhood of 10^{-3} cm³/sec at 1.0 volt applied to the electrodes. It will be remembered that a flow rate of 10^{-5} cm³/sec through a separated detector will yield some 100 microamperes output, so that the values of flow rate produced by the electro-osmotic cell easily cover the working range of the other electrochemical units.

An idea of the power gains obtainable with these electrochemical units may be illustrated by combining the electro-osmotic cell with a linearly operating separated detector. The current drawn by the electro-osmotic cell at 1.0 volt applied can be held to about 30 microamperes if the working fluid has a conductivity of some 10^{-6} ohm $^{-1}$ cm^{-1}, giving a power input of 30 microwatts. The linear detector coupled to the cell can be designed to give an output of 10 milliamperes dropped across a load resistor of 100 ohms, or a power output of 10 milliwatts. This represents a power gain of some 330 fold; this could easily be increased by an additional order of magnitude.

One of the essential requirements of a properly operating electro-osmotic cell is that the working electrodes polarize as little as possible. For alternating current signals this is no particular problem, but for continuous and uni-directional d-c signals, suitable electrodes are not so easily found. To date, the most satisfactory electrodes have been the simple metal/metal-ion type, particularly Ag/Ag made by firing compressed tablets of AG²0.

Another method of obtaining the conversion of electrical energy is through the use of the electro-capillary curve of mercury. This has not been studied as thoroughly as has the electro-osmotic cell, but its workability has been demonstrated. The most interesting thing about the electro-capillary curve is the fact that the surface tension (and thus the fluid displacement) varies as the square of the voltage applied to the interface. Furthermore, because of the extremely low currents required to charge the mercury double layer, and the relatively large displacements obtainable by the changes in surface tension, the power gain through such a system can be higher even than the examples cited above.

Use of anodically deposited iodine

The last aspect of these electrochemical devices to be described in this paper is the use of a reducible substance (iodine) formed in place by the passage of anodic current through the electrolyte solution. For example, fig. 9 shows an anode and cathode separated by a small volume containing KI only. Other cathodes are shown at the ends of this "corridor," through which the fluid is free to flow. Now, obviously, since there is no iodine inside the corridor, no current is obtained at the end electrodes, regardless of the fluid flow. If, however, an external current is passed across the corridor pieces, iodine will be formed at the anode of the corridor, which will then either diffuse across to the cathode, or may be forced to either of the detector gauzes by fluid flow.

The iodine thus generated, and subsequently reduced at any of the three cathodes shown, may then be returned to the anode again and again, with the result that a small, steadily applied generating current builds up into a larger and larger cathodic current, which can, at a preselected point, be shunted to another part of the cell, thus returning the corridor to its initial "iodine-free" condition.

By the use of the principles just described, operations such as multiplication and integration may be carried out. Obviously, the ramifications and possibilities of these electrode arrangements are numerous. END

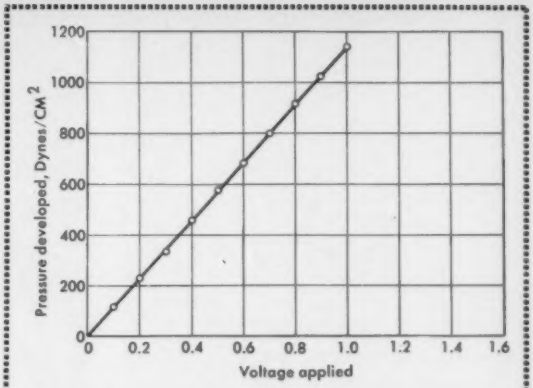


Fig. 8. Pressure-voltage curve of an electro-osmotic cell

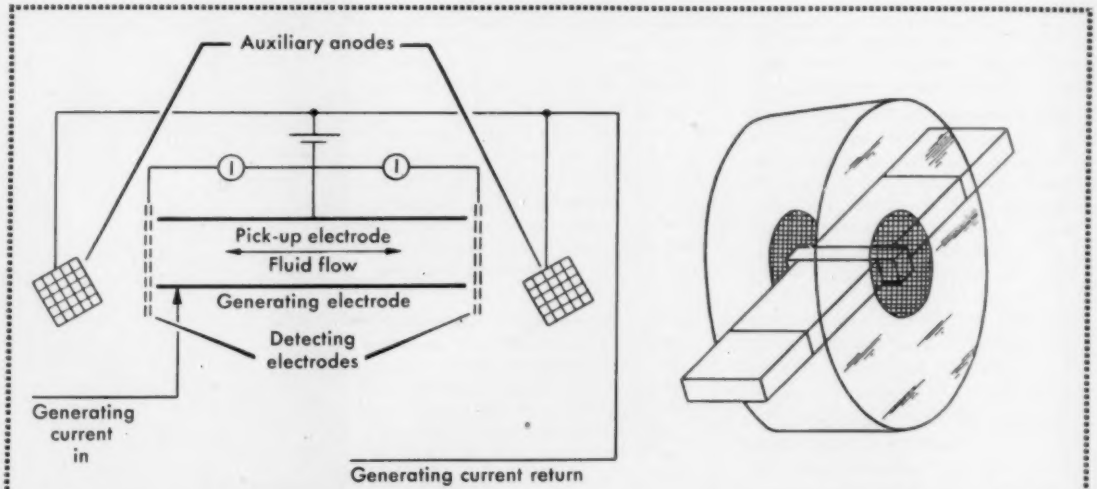
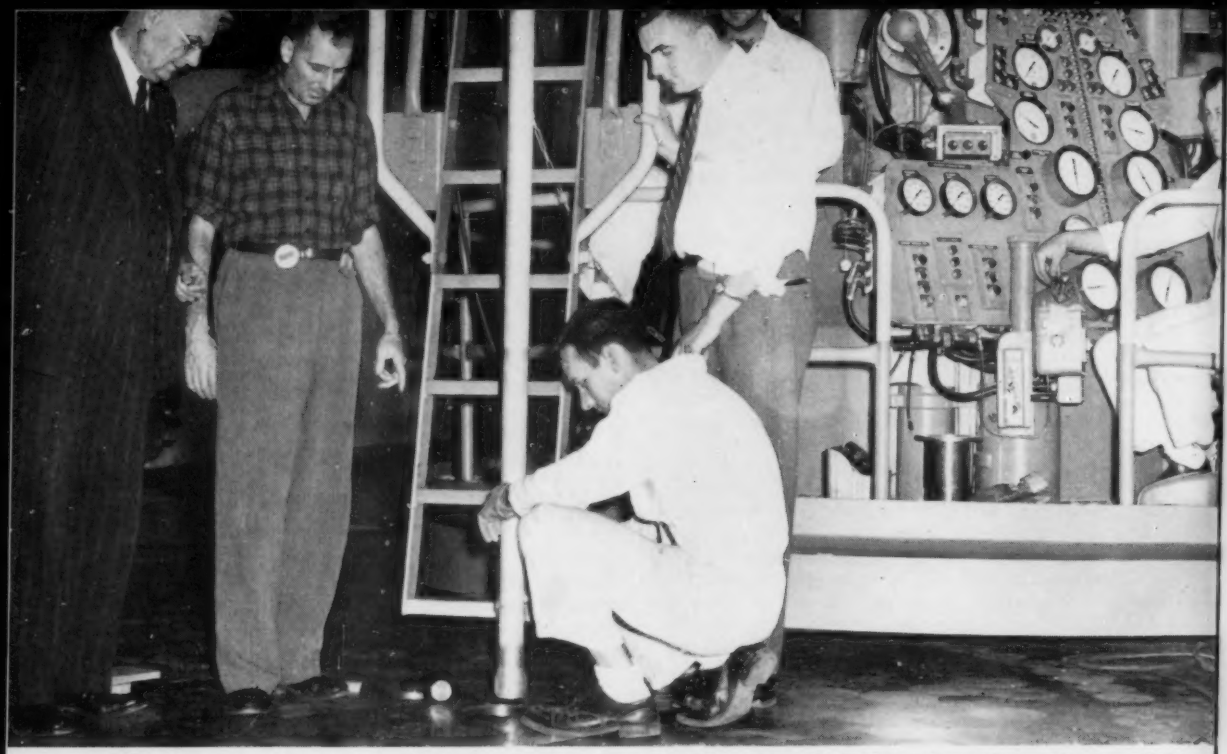


Fig. 9. Schematic and cut-away view of corridor show electrode arrangement for using anodically deposited iodine



Dr. D. A. Keys, left, Scientific Adviser to the President, A.E.C.L., inspects loading of uranium rod into NRU

NRU goes critical

At 6:10 a.m. on Nov. 3, the NRU reactor at Chalk River went into operation. The first few weeks will be spent testing and evaluating the reactor at low power before raising it to its rated capacity of 200,000 kw thermal. This is the Western World's most versatile high-power research reactor.

NRU has been designed to provide three things: research facilities, plutonium and radioactive isotopes.

The maximum neutron flux available will be 1.6 x 10^{14} neutrons per sq cm per second near the core of the reactor. Twenty-four ports in the reactor and thermal column will allow passage of neutron beams for research work, or insertion of samples. Materials may also be irradiated in the area between the reactor wall and the water reflector. To test fuel materials and sheaths, three independent loops are connected to tubes running through the reactor core.

Because NRU is essentially a research type reactor, it requires extensive control and instrumentation facilities. There are some 4,000 process instruments and 1,200 electronic devices built into the system.

University of Toronto plans reactor

The University of Toronto will be Canada's second school to install a nuclear reactor. It will be a subcritical type used to educate students in reactor operation and theory.

The reactor will be operated by the Faculty of Applied Science and Engineering and will occupy two floors of the Wallberg Building. It will cost $439,000, of which $200,000 will be for heavy water. Three tons of uranium worth $100,000 will be loaned by Eldorado Mining & Refining Ltd.

Design and construction of the reactor will be carried out by Canadair and will include a Honeywell electronic simulator. It is expected to be ready for the opening of the 1958 academic year.

A portable "hot cell" has been built by Westinghouse engineers for use in studying nuclear radiation. The cell has half inch thick steel walls spaced 15 inches apart. Between the walls are 35 tons of steel shot which can be drained out when the cell is to be moved. The shielding effect is equivalent to 10 in. of solid steel

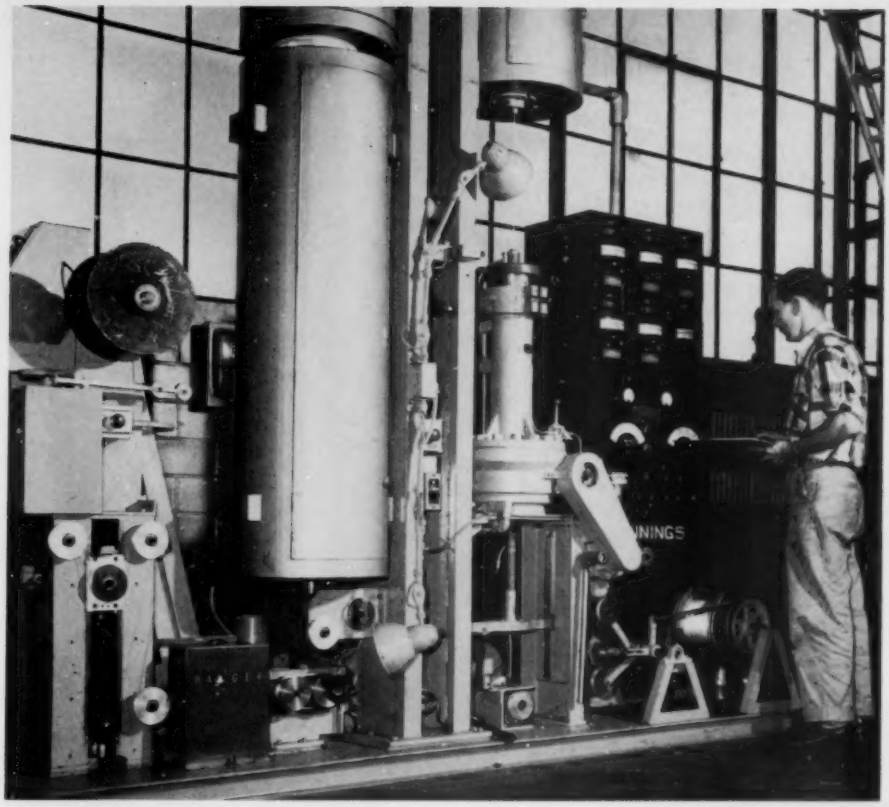


Fig. 1. Operator logs performance of the automatic extruder

New machine for "Teflon" extrusion

IAN R. DUTTON, ASSOCIATE EDITOR

"Teflon" is the latest development in our search for new electrical insulating materials. This tetrafluoroethylene resin can be used continuously at 482 F, has excellent electrical properties, is completely inert to all solvents and chemicals except molten alkali metals and fluorine, remains tough and flexible over a wide temperature range, has low coefficient of friction and zero moisture absorption.

There are six processes used in insulating wire with "Teflon," including three extrusion techniques, dip coating in enamel made from aqueous dispersion, calendering, and wrapping with tapes made from "Teflon." Of these, the extrusion process is considered to be one of the best methods of applying thin wall insulation on wire, but it requires special machinery to do the job.

Canada's first "Teflon" extruder has just gone into operation at Federal Wire & Cable Division of H. K. Porter Co. (Canada) Ltd., Guelph, Ont. Types E and EE hook-up wire (specification MIL-W-16878B) are being turned out now, with other types scheduled for the future.

These are the main steps in preparing the "Teflon" powder mix, making the pre-form, loading the machine, adjusting the controls and checking the final product.

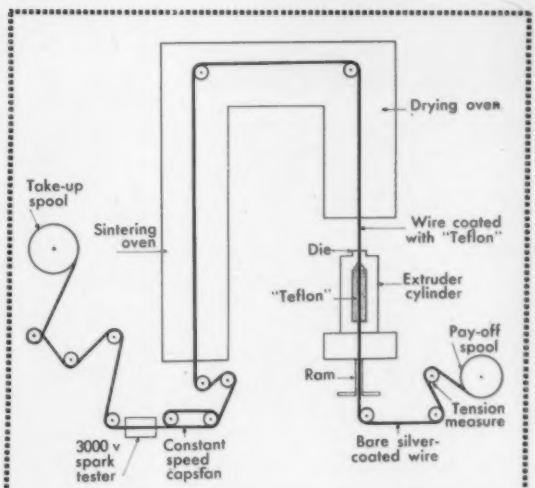


Fig. 2. Wire passes through extruder cylinder to drying oven. It is then sintered, spark tested and reeled

"Teflon" is the registered trade name of E. I. du Pont de Nemours & Co. (Inc.)

"Teflon", extruded under pressure is sintered at 621F

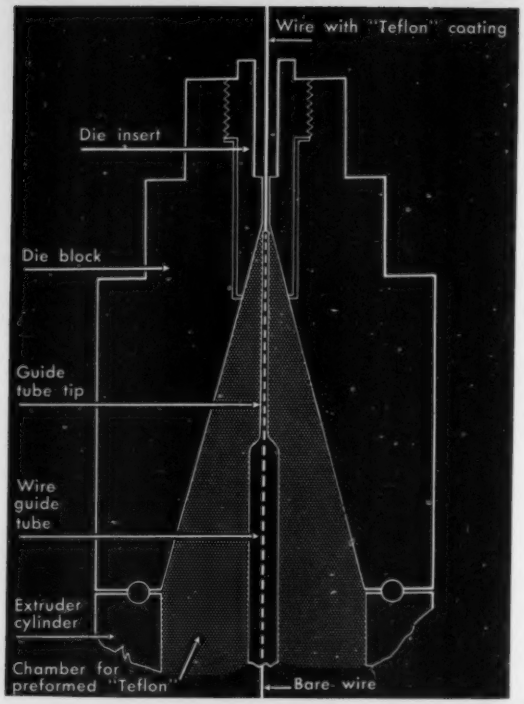


Fig. 3. Ram forces "Teflon" through die and causes it to form sleeve around moving wire. Die regulates diam of insulation

Fig. 4. "Teflon" powder is carefully screened and weighed, then pigment and lubricant are added. Dirt could cause breakdown of the insulation

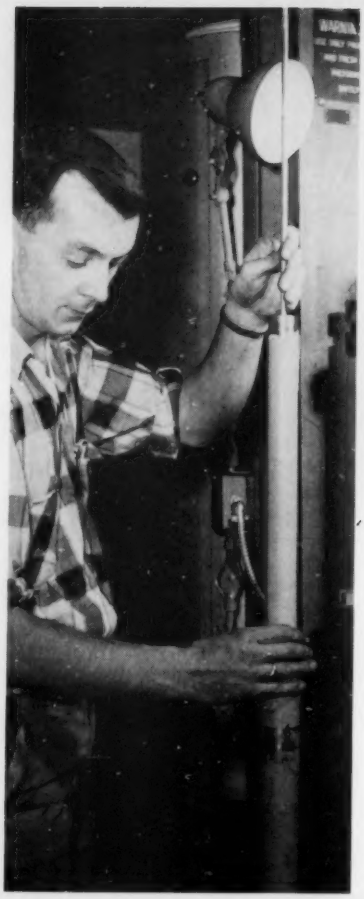


Fig. 5. The mix, preformed under pressure, looks and feels like a large candle with hollow centre

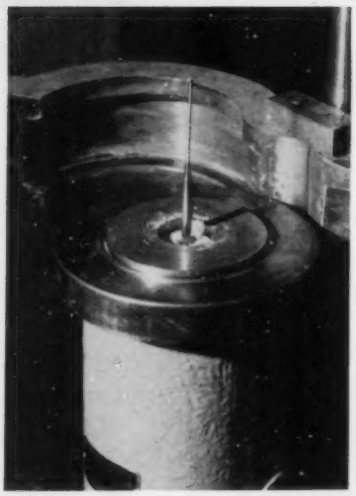


Fig. 6. The preform is loaded into the extruder cylinder. Hollow centre leaves clearance for wire guide tube

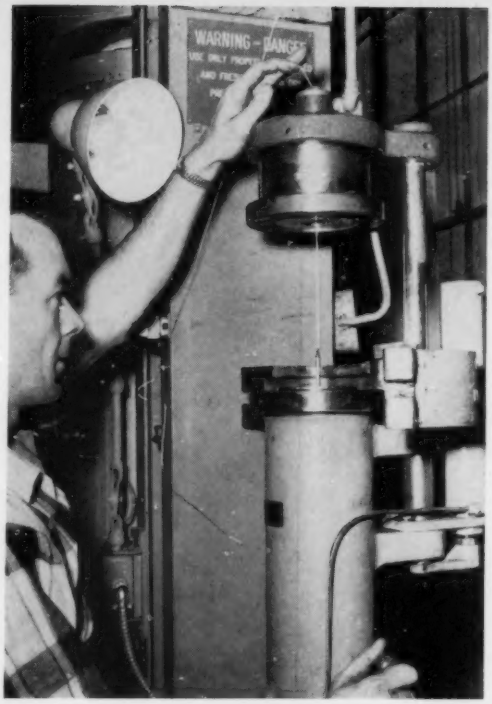


Fig. 7. The bare wire is threaded up from the wire guide tube through the die block. Block is then lowered and locked to extruder cylinder. Die is heated to assist flow of the "Teflon"

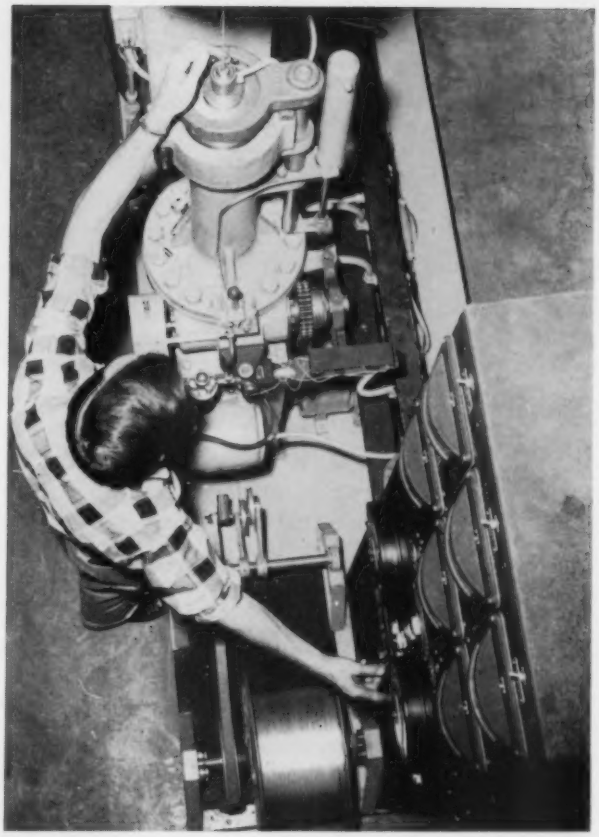


Fig. 8. Operator checks extrusion while adjusting the wire feed rate and the pressure of the ram

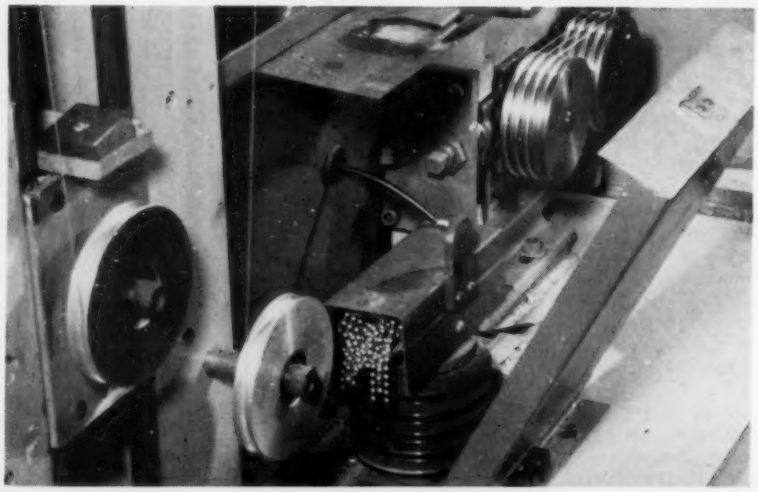


Fig. 9. Wire passes through spark tester before going onto take-up spool. A 10 mil wall of "Teflon" will withstand 3,000 v and a 15 mil wall will withstand 4,000 v test END

John Maunder shows the Sugden stereophonic pickup and disc. Recording is in vertical and lateral directions.

Stereophonic records at Canadian hi-fi show

Stereophonic has become the new word in the hi-fidelity field. At the Dominion High Fidelity Association's Exposition in Toronto, Ontario there was not only stereophonic on tape but, for the first time, on discs as well. The exposition, in Toronto's Park Plaza Hotel, had 35 exhibitors and attracted capacity crowds for the four days it was on. Altogether about 8,500 visited the show, with 7,800 paid admissions.

The new disc recordings have been produced by A. R. Sugden & Co. (Engineers) Ltd., of Yorkshire, England. The recording is made, simultaneously, in both vertical (the earlier "hill-and-dale" system) and lateral directions. Minimum interaction has been achieved by mechanically coupling the two cutting heads in a geometrical manner at a point where each system has a null position. This achieves a channel separation of the order of 25 db.

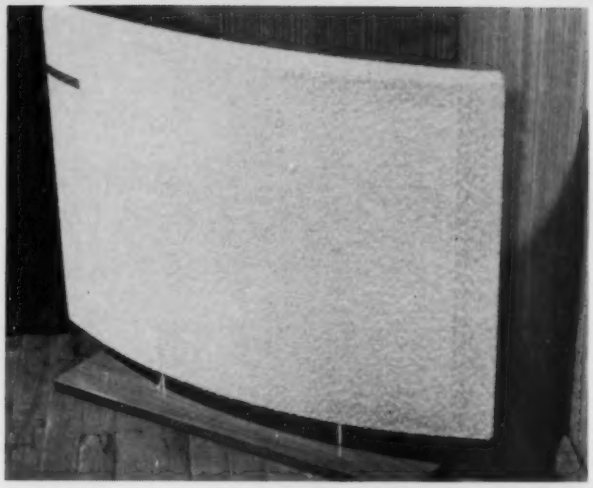
The play-back head consists of one stylus feeding two crystals, each crystal delivering about 20 mv. At the moment the best frequency response on the vertical recording is about 9,000 cps and on lateral 14,000 cps. Special recordings, produced by the Sugden Company, were played by Astral Electric Company Ltd. Several companies have shown interest in stereophonic discs and Decca may be issuing commercial recordings. These will be at 33 1/3 rpm and will run as long as ordinary lp's.

All the tape recorder manufacturers were demonstrating stereophonic, relying often on sound tricks with trains, table tennis games and marching bands to show the effectiveness of the systems to the full.

Ultra-lightweight tone arms attracted a lot of attention. Latest of these, the Shure Studio Dynetic, shown by A. C. Simmonds and Sons Ltd. has only one gram force at the needle point. The arm was demonstrated at the New York IRE Show earlier this year but this was its first time in Canada. It can be blown across the record without damaging it but at the same time will keep in the groove with the record at an angle of forty-five degrees. Shure engineers claim that after ten playings with a standard tone

Harold Leak, British amplifier maker, talks with H. Roy Gray, vice-president, Dominion High Fidelity Association

The Shure Studio Dynetic has only one gram force at the needle point. Here record is at 45 degrees



Among the electrostatic speakers was this one by Pickering. The frequency range starts at 400 cps and the price is $294.

Harry Clarke, of Cossar (Canada) Ltd. with the 1,000 ohm speaker being used in experimental work on transistorized power amplifiers.

arm of six to eight grams force records are no longer hi-fi but with the Shure arm there is no sign of wear after hundreds of playings.

Another one-gram arm shown by Alex L. Clark Ltd. was the Weathers FM pickup. Here the stylus passes impulses to an oscillator-modulator which produces a signal with a signal-to-noise ratio of 60 db. Response for the arm is claimed as flat from 20 to 20,000 cps.

Three transcription turntables were of interest. McCurdy Radio Industries Ltd., Toronto are making The Canadian in this country. The table weighs 5 lb. and is of precision machined aluminum. The wow factor is within plus or minus 0.2% of the mean speed. McCurdy were also showing McIntosh amplifiers which they now manufacture in Canada under license. The McIntosh amplifier "unity-coupling" circuit guarantees less than one third of 1% harmonic distortion and less than one half of 1% intermodulation distortion for any frequency throughout the audible range at full output.

The Garrard 301 transcription turntable had a variable speed control and is delivered with an individual inspection report and owner's manual. Sales agents are Chas. W. Pointon of Toronto. J. B. Smyth of Montreal had, for the first time in Canada, the "Musicmaster" turntable, a Japanese production, which included a built-in stroboscope.

Loudspeakers were in all shapes and sizes. Electrostatic speakers came from a number of manufacturers with the full-range electrostatic of the British Acoustical Manufacturing Co. Ltd. (J. B. Smyth, Montreal) being demonstrated for the first time in North America. Research program on the speaker began in 1947 and the first demonstration was made in 1953. Electrostatic tweeters were shown by Janszen, Philco (66 electrostatics built into a radial arc) and Pickering. Hartley Products (J. J. MacQuarrie Sales, Toronto) showed for the first time a speaker with a new polymerized cone, lighter yet stiffer than previous cones. Cossor (Canada) Ltd. had a 1,000 ohm speaker which is being used in experimental work on transistorized power amplifiers.

Speaker system for $1,200

Most expensive loudspeaker system was the Electro-Voice Patrician—a four-way corner system at around $1,200. There was also the Acoustic Research AR-1, chosen by the Audio League as their reference speaker. Speakers are built into a sealed cabinet. The air in the cabinet replaces the mechanical spring of the bass speaker suspensions, reducing distortion to about five per cent at 30 cycles.

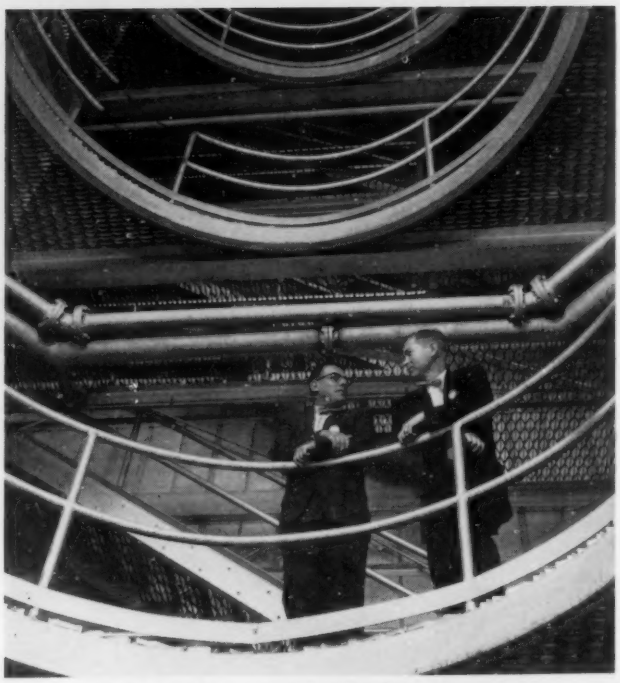
Other loudspeakers were shown by such well-known names as Jensen, Goodmans, J. B. Lansing, Wharfedale, University of Tannoy. Wharfedale had an interesting three-speaker system. Two speakers with a very low bass resonance were mounted in parallel on a single sand-filled baffle and the tweeter was at the top of the baffle, pointing upward. The system was only 12 inches deep.

A new tape-recorder on show was the Tandberg from Norway. Frequency response, plus or minus, 2 db, was given as: 7½ ips 30-17 kc, 3¾ ips 30-10 kc, 1⅞ ips 30-5 kc. The Tandberg is handled by Engineered Sound Systems in Toronto. Other new products included an Electro-Sonic Laboratories concert series cartridge now being made in Canada by J. B. Smyth of Montreal.

The build-it-yourself department had the Schober Organ (J. J. MacQuarrie, Toronto). This is a fully equipped concert organ built from 23 kits, using over 100 printed circuits. Building time, say the makers, is around 200 hours but you end up with an electronic organ worth at least twice what you paid for it. END

Canada's latest supersonic

A large sized wiring jig, emphasizing the complexity of modern electronics, makes a fine photographic study. Picture by N. V. Philips of Eindhoven



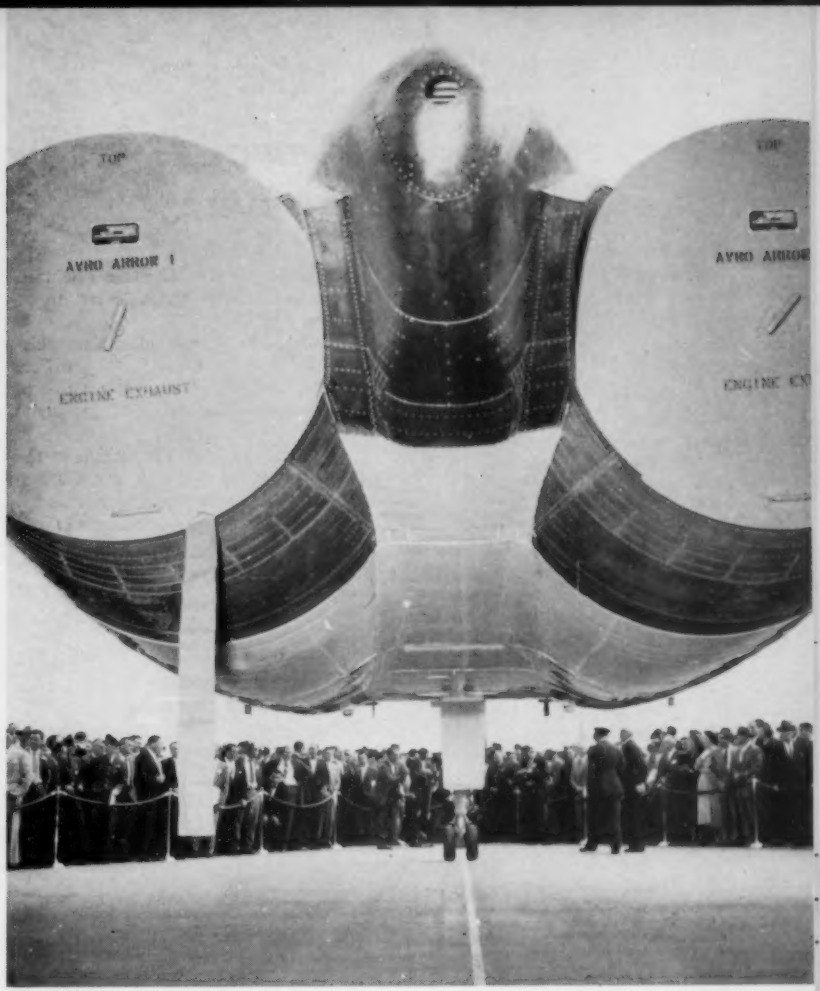
Steel platforms in ascending levels make this geometric pattern in an Atlas Intercontinental Ballistic Missile test facility at San Diego plant of Convair. Pressure tests are made here on Atlas fuel tanks.

Transistors and miniature battery cut hearing aid weight

New hearing aid, the Sonotone "222," with the aid of transistors becomes smaller than a nickel. Total weight is only half an ounce, using a "button" battery. Left is the unit, with three transistors, and right, its chassis

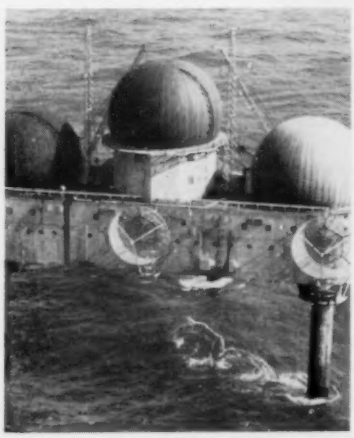
aircraft...

PICTURE OF THE MONTH ▸



An unusual angle shot of Canada's latest supersonic aircraft—the Avro Arrow, or CF 105. The plane, literally, is two jet power units with wings. Over-all length is 78 ft. and total wingspan 50 ft. With the plane rated to travel at 1,200 mph the electronic problems involved in the control system are enormous. Interception and fire control at this speed must be automatic for a pilot may require half a mile to react to a new situation

Flashback: the early days of electronics



Towers on stilts off Cape Cod, Mass., are part of a scatter link. Makers are D. S. Kennedy

In 1922 Radio-France was on the air with this equipment. Left, hexagonal loop receivers, Villecresnes; right aerial inductance coils, Sainte-Assise

For your library

Electronics student needs wide physics background

Fundamentals of electron devices

Karl R. Spangenberg. McGraw - Hill Company of Canada Ltd.; 505 pp; $12.00.

As the title indicates, this book, which is an undergraduate text, emphasizes the physics of electron devices more than is usually done in such treatments.

As the author says it was possible, at one time, to study electronics after learning a little about the operating characteristics of vacuum tubes and without too much regard for how these operating characteristics came about. But with the transistor all that is changed.

So the emphasis is on the similarities between tubes and transistors rather than differences. This is done through the common denominators of semiconductor and potential theory.

The book stresses the internal physics of the devices and discusses the role physics plays in determining the external characteristics. A fundamental treatment of commonest circuit applications is also included; about 60% of the book is devoted to the devices themselves and the remainder to their circuit applications.

In the work on devices transistors get the lion's share of attention because they are newer and, in some respects, more complex. There is a detailed treatment of energy levels in semiconductors and the influence of these on junction effects, emission and photo-effects.

There are numerous problems included in the text and these should be of great help to the student. Eleven appendices give the origin of basic relations and tabulate important facts. There is also an excellent bibliography. This is a book that more than fulfills the tasks it sets out to do.

Closed circuit TV

Morris A. Mayers and Rodney D. Chipp. John F. Rider Inc.; 250 pp; $10.

The use of closed circuit TV in every field of commerce and industry is increasing rapidly. It has been used in Canada for simultaneous meetings between company executives and field staffs for cities as far apart as Winnipeg and Quebec and when the trans-Canada telephone link is completed early next year it will certainly be used in coast-to-coast hook-ups by major companies.

This book explains what closed circuit TV can do in the factory, office, school, hospital, department store and many other business and industrial areas.

It answers questions relative to the organization of closed circuit TV systems, dealing with space requirements, cost of equipment and installation, types of equipment available and manpower needed to maintain and operate it. A book for the executive, full of facts.

Electronics in Action
The current practicality of electronic data processing

Special Report No. 22, edited by Elizabeth Marting. American Management Association, Inc., New York; 156 pp.; members $2.50, non-members $3.50

Previous reports by AMA on electronic data processing (EDP) have charted the work of the pioneer users, who are now reaping the benefits of several years of experience. As a management tool, EDP has clearly proved its value; this report, therefore, focuses on the current practicality of EDP, providing a graphic picture of electronics in action today.

The report comprises a foreword by Clifford J. Craft of AMA and thirteen papers by representatives of companies with well-established EDP programs. The papers describe the latest developments in all areas of EDP—feasibility studies, installation, selection and training of personnel, applications evaluations, and new frontiers. This material was originally presented on February 25-27, 1957, at the Third Annual Electronics Conference and Exhibit, sponsored by the Finance Division of AMA and held at The Statler Hotel in New York City.

Basic mathematics for electricity, radio and television

Bertrand B. Singer. McCraw-Hill Co. of Canada Ltd., Toronto; 513 pp; $7.50.

This is an excellent practical course in mathematics, going as far as the use of trigonometry and vectors in series and parallel a-c circuits. It will also provide a refresher course in the mathematics needed by the skilled mechanic in electricity, radio and television.

The material is presented in "job" form. Each "job" develops either a new mathematical operation or a new electrical concept, is illustrated by a series of examples which increase in both arithmetical difficulty and electrical scope and has its own set of practical problems carefully graded.

As the author says, this illustration method makes the book particularly suitable for the students for whom it is written. The review jobs tackle the problems in the chapter from a slightly different point of view so as to round up any possible loose ends in the student's mind.

Mr. Singer is instructor of radio and television mathematics, Samuel Gompers Vocational and Technical High School, New York.

Catalogues and brochures from the manufacturers

Radiotron characteristics manual by Canadian Marconi Co. New edition has 200 pages and is available through jobbers at 50c. (769)

Principles of microradiography and bibliography of microradiography and soft x-ray radiography. Philips Industries Ltd., Toronto. 43 pp. (770)

The how and why of high fidelity. Daystrom Ltd., Toronto; 25c. 47 pp. (771)

How to use platinum resistance thermometers in temperature measurement, telemetry, and control. Trans-Sonics, Inc., Burlington, Mass. 15 pp. (772)

Lincoln Laboratory M.I.T. 12-page book describes origin, organization and activities. M.I.T. Lincoln Laboratory, Lexington, Mass. (773)

Microwave ferrite devices. 8-page brochure describes basic principles. Sperry Gyroscope Co., Great Neck, N.Y. (774)

Transistor manual, second edition, 112 pp; 65c. Canadian General Electric Co. Ltd. (775)

Sta-Kon pressure terminals and connectors. Bulletin S7. Thomas & Betts Ltd., Montreal. (776)

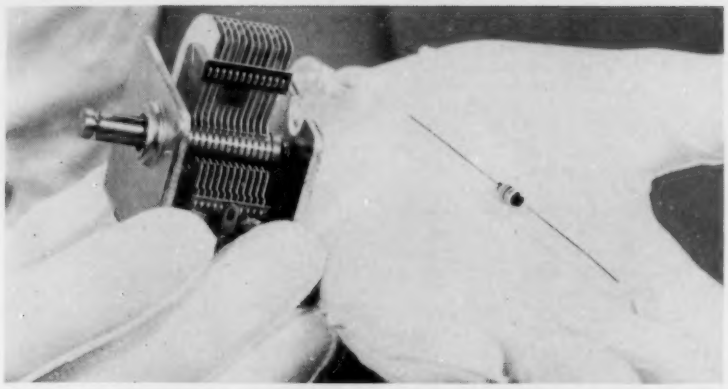
Crimping tools, taps and splices for aluminum and copper conductors are described in bulletin UT5. Thomas & Betts Ltd., Montreal. (777)

Index of products lists over 700 products made or sold by Canadian Industries Ltd., Montreal. (778)

Is automation your problem? Two-page list of Meltrols. Mel Sales Ltd., Arnprior, Ont. (779)

Autrometer, automatic indexing X-ray spectrograph. Philips Industries Ltd., Toronto. (780)

Variable capacitor is controlled with bias voltage



A new solid-state device has been developed and named the Varicap. This is a variable capacitor in which the capacitance can be changed by altering the applied bias voltage. This phenomenon has been known to solid state physicists but the Varicap is the first production model to become available.

Some of the advantages include size and weight reduction and significant improvement in service reliability over the mechanical tuning capacitor and the reactance tube. In addition, the capacitance does not change with temperature. Models presently available have their mid-range capacitance from 20 to 56 micro microfarads and each model can be varied from 50% to 225% of this rating.

Expected use will be in voltage tuning, frequency modulation, and automatic frequency control.

Pacific Semi-conductors Inc., Culver City, Calif. (781)

VHF transmitter has one kv rating

Model PTC-3600 is a medium power transmitter designed primarily for airport ground-to-air operations and also for teleprinter and vhf point-to-point links. It is basically a two unit transmitter; the rf and modulator sections are assembled in self-contained cubicles which are combined into a composite equipment for r/t service.

The frequency range from 118 to 136 mc is continuously covered. The drive unit consists of a crystal oscillator followed by three harmonic generator stages, providing a total frequency multiplication of twelve times the crystal frequency. These stages are followed by two push-pull stages which drive the amplifier.

Forced air cooled tetrodes are used in the rf output stage and radiation cooled triodes are used in the modulator. The transmitter may be remotely controlled and is fully protected against damage due to overloads and maladjustments.

Pye Canada Ltd., Toronto. (782)

Continuous pH meter is independent of temperature

Model 904 industrial pH measuring system is designed to continuously measure pH as a chemical process variable. It can measure at pressures and temperatures as high as 200 psi and 200C. The system incorporates temperature compensation so that the output is proportional to the true pH regardless of process liquid temperature. Range selection is accomplished by replacing a plug-in range unit within the amplifier to achieve two, five and ten pH for full scale deflection.

The system includes flow assembly, differential pressure regulator, pH transmitter and recorder.

Canadian Aviation Electronics Ltd., Winnipeg. (783)

Gamma radiation monitor

Model GA-3B radiation monitoring system is battery operated and self-contained. It consists of a control unit with meter relay, manual reset, 3 or 6 decade log scale, calibration controls, electronic calibration test adjustments and 10 mv recorder output. The remote monitoring system incorporates calibration methods allowing for complete electronic check and adjustments at both ends of the scale independent of radiation.

Models GA-3BA and GA-3A are available with ac-dc power supply (fail-safe to dc) and straight ac respectively. All models will measure, display, record and control alarms for gamma radiation from background 0.025 mr/hr to 100 kr/hr or higher in the energy range from 80 kv to 1.3 mev.

Riggs Nucleonics Co., Altadena, Calif. (784)

Adaptor holds three accelerometers

Measuring vibration simultaneously in three axes can be done through the use of three standard accelerometers and an adapter block. Drawings for an adapter to hold Endevco accelerometers is now available. The adapter block can be made by local machine shops.

MEL Sales Ltd., Arnprior, Ont. (785)

Time meters monitor operating machines

An automobile odometer has been used in the type KT time meters to provide six digits. The meters are used to check operating time, shut-down time, total running life of machines and tools, and correct intervals for machine operation and servicing. All models measure either hours and tenths or minutes and tenths. Ratings include 120, 240, or 480 volts at 60 or 50 cps, with an operating temperature range of —67F to +150F. A reset is included on most models.

Canadian General Electric Co. Ltd., Toronto. (786)

Oven for drying and sterilizing work

The Scotsman oven suitable for drying and sterilizing work features hot wall heat, with no inside heaters, hydraulic thermostat, and temperatures up to 350F (125C). The interior chamber is 12 in. wide by 10 in. high by 9 in. deep with 212 sq. in. of shelf area. Double wall construction, with fibreglass insulation helps maintain even temperature and high efficiency.

Labline, Inc., Chicago. (787)

Ceramic tetrode for SSB handles 1,000 watts

Specifically designed for single sideband operation, the Eimac 4CX1000A is a low-voltage, high-current class AB, rf or af linear amplifier tube, exhibiting high power gain and low distortion characteristics. It achieves its maximum rated output power with zero grid drive, thus minimizing driver stage design problems and eliminating one source of distortion. Construction is ceramic-metal.

R. D. B. Sheppard, Ottawa. (788)

(Continued on page 48)

X-ray microscope has resolution of 1.0 micron at 2-20 kv

X-ray microscope techniques and other applications in metallurgical, rubber, plastics, mineralogical and other fields are possible with the projection microradiograph. The unit employs an X-ray source approximately one micron in size to produce enlarged images of specimens placed close to the radiating surface. Images are observed on a viewing screen and are recorded with a camera that accommodates five exposures on a 2 in. by 10 in. plate. Exposure time is approximately 1 min. at 10-12 kv and resolution is 1.0 micron or better at 2-20 kv.

The electron optical system includes an electron gun, high voltage source for electron acceleration, electromagnetic lenses to control beam size and configuration, and targets having surface planes normal to the beam at the end of its path. High voltage on the X-ray tube covers a range from 2-50 kv and is continuously variable.

Direct magnification up to 70X are possible on the photographic plate and up to 250X on the viewing screen-binocular combination. Total useful photographic enlargement is 1500X. Field of view at 2X magnification is approximately 15 mm and at maximum magnification it is about 1/2 mm.

Philips Industries Ltd., Toronto. (789)

Miniature adjustable limit stop

Adjustable limit stops for servo, instrument, and precision mechanism industries are available in two models, 0-10 revolutions and 0-40 revolutions. A single range-setting screw at the end cap can adjust the stop rotation from 0 to full scale continuously. The limit stop is 0.875 in. in diameter, synchro mounted, 1-5/32 in. long in the 0-10 turn model and 1⅞ in. in the 0-40 turn model. Shaft diameter is .125 in.

Precision Mechanisms Corp., East Meadow, N.Y. (790)

Continuous monitoring with printed readings

Model 7341B and its accessory printer can provide continuous monitoring with printed readings for a wide range of frequency, velocity, and rpm measurement problems.

The transducer signal (photocell, tachometer, generator, flowmeter, etc.) is counted during a known time base established by the instrument and the total count at that time is displayed directly in cycles or kilocycles per second, or rpm (with proper transducer). Time bases are established with electronic count-down from the line frequency which, in most areas, is normally accurate to 0.1%. During the display time stepping switches sample the indication and enter the readings on the printer.

Electro-Pulse Inc., Culver City, Calif. (791)

Synchronous motor uses permanent magnet

Designed for application in high-speed controllers, counters and metering devices, type 117 form H, synchronous motor is rated at 60 in. oz. at 1 rpm. It is offered in speeds from 72 rpm to 2 rpm with low input power (2.5 watts) and a maximum temperature rise of 35C. The motor reaches synchronous speed within two cycles of power line frequency and provides instant stop due to low rotor speed and magnetic braking effect. Left or right rotation is available in all speeds and the motors are designed for operation on power sources up to 250 v ac, 60 and 50 cps.

Burlec Sales Ltd., Toronto. (792)

Temperature control is explosion-proof

The D95, an explosion proof remote bulb temperature control is composed of two integral assemblies: a remote bulb thermo device and control head with connecting capillary tube of varying length. The remote bulb is exposed to the source to be controlled. The connecting capillary tube leaves the control head with its attached bellows free to be placed away from the source that is to be controlled. Models are available with adjustable range spans of —150F and 650F with on-off differentials of approximately 1F and 2F. Switches are available in any one of three standard types: normally open, normally closed or double throw with no neutral position and are rated for 15 amps at 115 or 230 volts ac. All switches are single pole and suitable for 180F ambient temperatures.

United Electric Controls Co., Waterdown, Mass. (793)

Oven is designed for components

Temperature regulation of ±3C over an ambient range of —55C to +100C is claimed for model AM-200 oven. This new oven is specifically designed for components such as capacitors, resistors, transistors, etc. The cavity measures one inch in diameter by two inches in length and is available with either plug-in or stud mountings.

Bulova Watch Co., Woodside 77, N.Y. (794)

Chamber controls atmosphere for welding

A plexiglass dome offers maximum visibility for welding such metals as zerconium, titanium, zecoloy-2 and others requiring controlled atmospheres. The unit consists of a 24-in. diameter upright chamber with a bubble type dome made from materials with low outgassing characteristics. The dome is spring loaded for production loading. By placing valving and pumping apparatus underneath the chamber, total floor space is held to 2½ x 3 ft. Maximum vacuum is 10^{-4} mmHg reached in approximately 15 minutes with a guaranteed leak rate of 15 microns per hour or less.

L. & B Welding Equipment Company, Berkeley 2, Calif. (795)

Megohmmeter has three test potentials

The Keithley Model 510 Megohmmeter can measure six decades of resistance on a single 6 in. mirror scale that is linear with no compression at the high end. With its 5, 50 and 500 volt test potentials, the instrument provides a selection of safe voltages for measuring all test samples and for checking voltage co-efficients.

MEL Sales Ltd., Arnprior, Ont. (796)

Particle accelerator is portable

The "junior" accelerator built by Societe Anonyme de Machines Electrostatiques, France, can be transported in a truck for use in the field. The accelerator is supplied by a 150 kv Felici electrostatic generator and is rugged and simple to operate. With the deuterium-tritium reaction, the accelerator produces 10^{9} neutrons/sec of 14 MeV energy level with deuterium-deuterium reaction, the accelerator produces 5 x 10^{8} neutrons/sec of 2.5 MeV energy level.

Dominique Gignoux, New York. (797)

(Continued on page 51)

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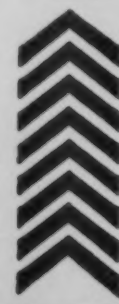

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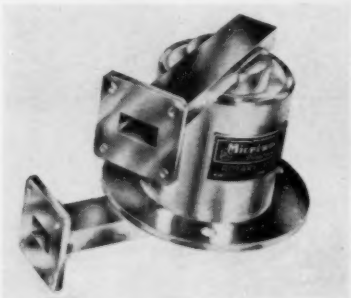
Rotary joint for Ku-band

For use in radar and other microwave applications which require relative rotation between two waveguide members the Ku-band rotary joint (illustrated) has been developed. The type MA-651 rotary joint will handle rf peak powers close to the maximum power capability of RG-91/U waveguide. It may be pressurized up to 60 psig for increased rf power handling capability. Frequency range is 16.3 to 16.7 kmc with other high power rotary joints available in the 35 kmc frequency range.



The type MA-306B dual TR tube (bandpass) has been designed for use with short-slot hybrid couplers. Input and output flanges mate with couplers in RG-51/U and RG-52/U waveguide respectively. Peak power rating is 500 kw, average power rating is 500 watts. In the operating frequency range of 8490 to 9578 mc, the vswr is 1.2 maximum.

For pulsed radar applications in the KA-band, model MA-1032 duplexer is designed for use with the 5790 TR tube and ATR-5791. The frequency range is 34.5 to 35.225 kmc, and the vswr over the bandpass is 1.20 maximum for transmitting and 1.15 maximum for receiving. Model MA-1032A contains a 36db waveguide output coupler arm, to provide a reference signal for automatic frequency control purposes.

EG Lomas Co., Ottawa. (798)

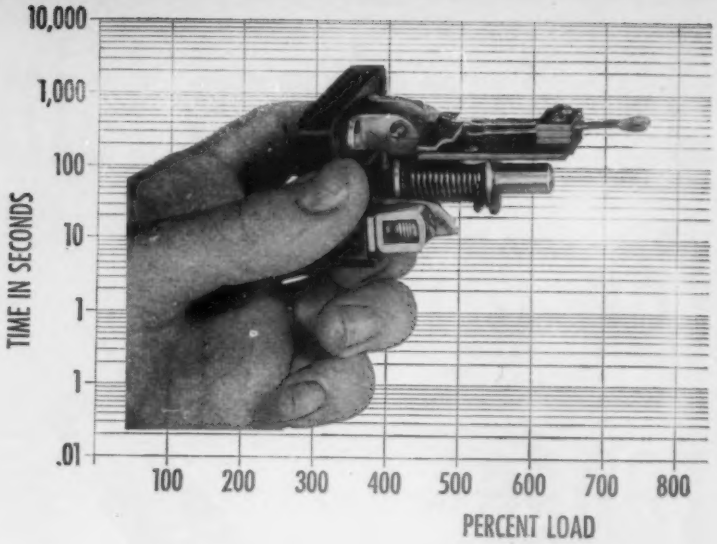
Miniature transformers for audio and carrier frequencies

Miniature transformers for handling a wide range of audio and carrier frequencies have been designed especially for mounting on printed wiring boards. Core structures on these new transformers are nickel-iron laminations for the audio frequency units, and ferrite for those in the carrier frequency ranges.

Cases are made of injection-molded phenolic in two sizes, 1 1/16 in. x ¾ in. x ¾ in. and 1 1/16 in. x 15/16 in. x 1⅛ in. After assembly the units are filled with an epoxy casting resin.

Stromberg-Carlson, Rochester 3, N.Y. (799)

(Continued on page 52)



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this overload relay is now tailored...to *your* equipment

NEVER BEFORE has any practical overload protector offered such close-tolerance specifications.

In most ratings, the Heinemann Silic-O-Netic Overload Relay may now be specified to trip on overloads as small as 15%. Time-delay characteristics can be selected which will permit starting inrush yet give high-speed tripping at critical load points.

Operating on the hydraulic-magnetic principle, this relay will always carry its full rated load despite ambient temperatures. It establishes a new and fully dependable close-tolerance between "must-hold" and "must-trip" current values.

Now, Silic-O-Netic Relays are available with tailored response characteristics. Within limitations, you specify the current value and the tripping time. Here is the ideal means of protection . . . an overload protector precisely rated in current and time delay to your specific equipment.

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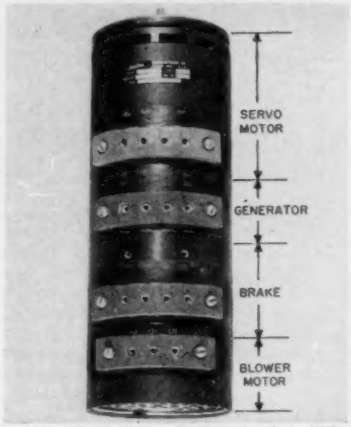
Four-in-one motor

Type 23-MTG-6327-O1 is a single unit combining a size 23 1/15th hp at 6,000 rpm servo motor; a damping tach generator with an output of 1.5 v per 1,000 rpm nominal and null voltage of 0.15, and linearity of ±2% up to 6,000 rpm; 28 v dc brake; and a blower capable of cooling the entire unit. It is available in any combination of its components and was designed for driving antennas and other self-cooled drive motor applications. Over-all dimensions are 8.1 in. long max x 2.88 in. diameter.



John Oster Manuf. Co., Racine, Wisconsin. (800)

Pulse generator has reversible output

Model 138 pulse generator produces pulses over the range of 1 microsecond to 1 second — singly, recurrently, single pairs, recurrent pairs, single trains and recurrent trains. The output is reversible and supplies 35 volts into 50 ohms. Intended use is in the fields of sonar, digital computers, acoustics, countermeasures, geophysics, analog computers and radar.

Repitition frequencies from less than one cps to 250 kc are available internally. The instrument will follow external sync anywhere in this range aperiodically or periodically.

American Electronic Laboratories, Philadelphia. (801)

Variable vacuum capacitors in ceramic case

Ceramic enveloped vacuum dielectric variable capacitors are available under the trade name VariVac. Three size groups will have maximum engaged capacitance ranging from 10 to 500 uuf and with maximum voltage ratings up to 25,000.

United Electronics Co., Newark, N.J. (802)

(Continued on page 53)

Lenses for infrared

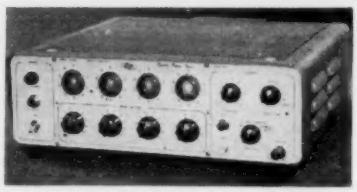
Servofrax Meniscus Lenses are single-element infrared lenses designed to give optimum performance under certain conditions, where achromatic imagery is not required. They are designed to have minimum spherical aberration when imaging an object at infinity at a dominant wavelength of 3½ microns. Reasonably good performance extends from 2 to 5 microns. Good transmission is obtained from 1 to 12 microns. Anti-reflection coatings are available for any specified wavelength in the 1 to 6 micron range. Focal lengths from 2 to 12 inches are available at relative apertures of f/2.0 and f/4.0.

Servo Corp. of America, New Hyde Park, N.Y. (803)

Preset counter and digital frequency divider

Model 7240B is a four decade instrument with fast recycle for such applications as batching and frequency division. Switches, photocells, pressure or magnetic pickups, strain gauges, etc. are typical transducers.

Outputs upon reaching the preset count, include a coincidence pulse for triggering other electronic equipment. An adjustable width gate for actuating external equipment, and dpdt relay. Preset counting capacity is 1 to 9,999 input events with absolute accuracy. Side brackets adapt the unit to relay rack installation.



Electro-Pulse Inc., Culver City, Calif. (804)

Dual-mixer-monitor for telemetering

Each half of the dual mixer monitor provides facilities for mixing as many as four independent input channels of data or timing signals on to one composite output for recording on a single track of a magnetic tape. Frequencies from 300 cps to 1,000 kc can be accommodated on each channel.

The monitoring feature permits independent monitoring of any of the four inputs, the composite output, for any three auxiliary signals. A zero centre meter provides direct readings in db. The dual mixer monitors are available as units or as complete packaged systems.

Radionics Ltd., Montreal. (805)

(Continued on page 54)

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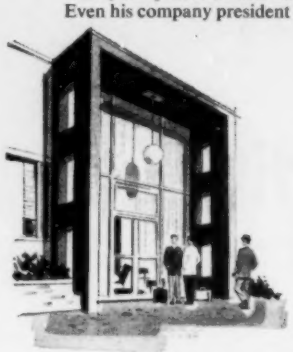

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If you are responsible for the maintenance of a large quantity of Tektronix Instruments, ask your Field Engineer about the factory training course in maintenance and calibration. Many companies have sent their chief instrument-maintenance engineers to Portland for this free course, and have been mighty pleased with the results. Your Tektronix Field Engineer will be happy to set up a factory training course for you if your company approves. He's your best source of information on this program and anything else related to Tektronix Instruments.

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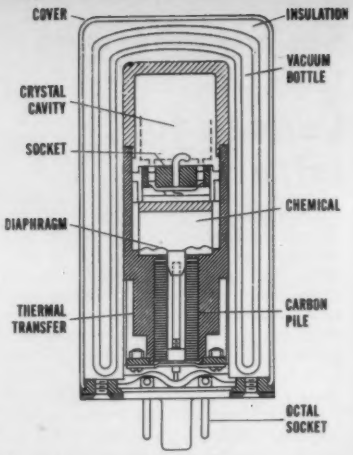
Instead of using the conventional bimetallic thermostat this crystal oven utilizes a chemical with proportional heat control to maintain the following rated temperatures. At 24C ambient, cavity temperature is 70.6C. Temperature control is with ±0.5C from —20C to +50C ambient and approximately ±0.005C at fixed ambient. The heater voltage is 5 volts ac or dc ±2% and the power consumed varies from 1.6w at 24C ambient to 3.5w at —20C ambient. The 12-oz. oven measures 2 in. in diameter by 4 in. high.

Robertshaw-Fulton Controls Co., Anaheim, Calf. (806)



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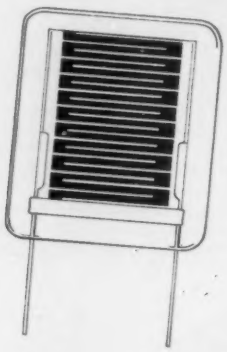

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These motors, slightly over 1 in. in diameter, feature a rotatable brush holder which is adjustable for best commutation and power output. All armatures are wound with heavy Formvar wiring utilizing Mylar insulation. Stock sizes are rated at 6, 12 and 27.5 volts but other windings and mechanical modifications are available on special order.

Servo-Tek Products Co., Hawthorne, N.J. (807)

Transistorized relay uses only 2 microwatts

Transistorized relay type 160, designed for dc applications will pick up as low as 20 microamps at 100 millivolts. Contact combinations range from spst through 4 pdt. The transistor is self-enclosed within the relay case and may use either an external or internal power source. The internal source is battery powered using long life miniature mercury batteries packaged within the relay enclosure.

Incorporating a contact wiping action, the expected life of the relay is well over several million operations. Contact capacity is 1 amp inductive or 3 amps resistive at 115 vac or 29 vdc. Available coil resistance is up to 30,000 ohms.

General Automatic Corporation, Mountainview, N.J. (808)

Medium power diffused-base silicon transistors

Two new transistors have been developed to deliver four watts at 25C case temperature and 1-watt at 150C case temperature dissipation ratings. Both are diffused base N-P-N transistors featuring a typical saturation resistance of only 20 ohms at 25C plus an operating range of —65C to +200C. They are temperature stabilized at 215C.

Type 2N497 is a 60 volt transistor for use with the 28 volt power supplies employed in military aircraft. The 2N498 is a 100 volt transistor for use in higher voltage applications such as servo amplifiers for missiles. They have 8 volt minimum emitter-to-base ratings and typical static forward current transfer ratios of 20.

Texas Instruments Inc., Dallas, Texas. (809)

(Continued on page 56)

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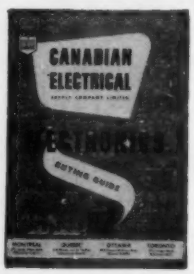

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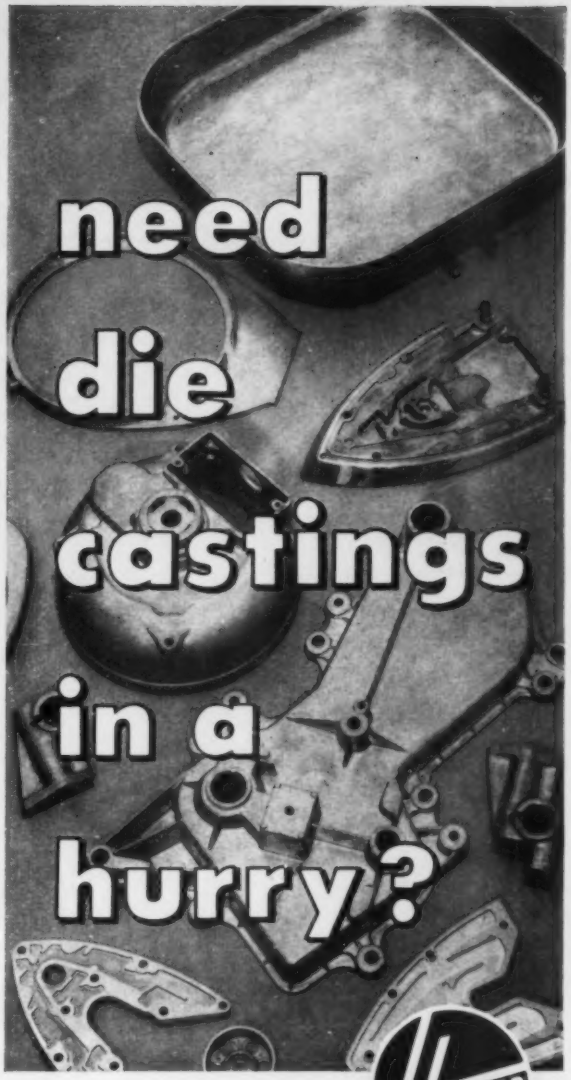

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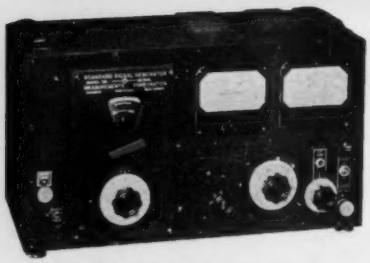

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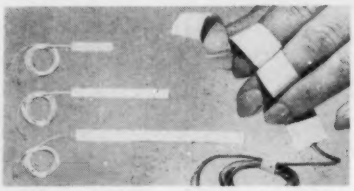
New products — continued

Adhesive ribbon detects surface temperature

Monitoring and controlling temperatures of surface areas can be done with flexible Thermo Ribbon. The Ribbon consists of a resistance element of high nickel content alloy wire encased in a flexible outer covering. Less than 0.02 in. thick, the ribbon may be cemented to flat, cylindrical or irregular surfaces. Self-adhering types are also available. These are manufactured in several shapes and sizes for operation over wide temperature ranges and varying physical conditions.



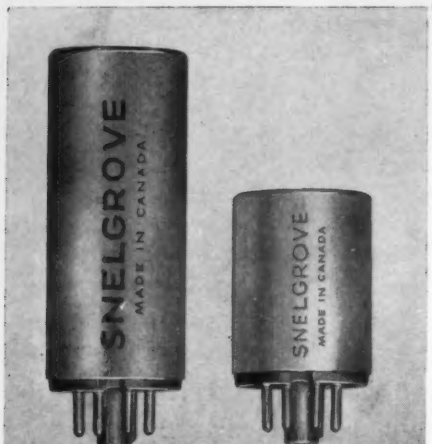
Minco Products Inc., Minneapolis, Minn. (810)

Tubes for TV vertical deflection application

A new octal-based T-9 high perveance, low-mu triode has been designed for use as a vertical deflection amplifier tube in wide angle television receivers. Type 6CK4 has a maximum plate dissipation of 12 watts and an average cathode current of 100 milliamps. With a maximum peak positive pulse plate voltage of 2,000 volts (absolute) and a maximum peak cathode current of 350 milliamps the 6CK4 is practical for both black and white and color television applications.

Two 9-pin (T-6½) miniature beam power pentodes have been designed for vertical deflection and amplifier application in television receivers with 110 deg deflection systems. Designated types 6DW5 and 12DW5, both tubes, capable of operation at relatively low B supply voltages, are characterized by high zero-bias plate current. Double base pins for the number 1 grid permit cooler operation. An electrically isolated plate pin helps each tube to withstand high pulse plate voltages. Maximum plate dissipation is 11 watts and maximum screen dissipation is 2.5 watts.

Sylvania Electric Products Inc., New York. (811)



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Isophon Electrostatic Speaker

(2" x 6¼" x $\frac{3}{16}$")
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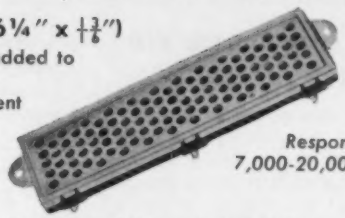

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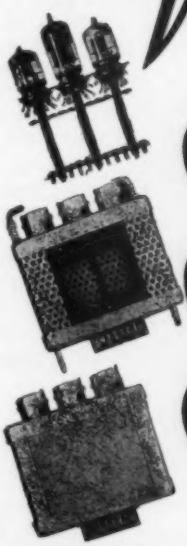
Unitize—Miniaturize

WITH *Vector* STRUCTURES FOR CIRCUITRY



TAKE ONE STRIP TURRET

Choice of Deck, or Wall type strips in many sizes offers miniaturization, accessibility, ease of assembly and adaptation to semi-automatic machinery.

ASSEMBLE IN LIP-LOC CASE

A sectionalized case with a choice of plugs, quarter turn locks, ventilated or solid wall; with two piece center section or snap-open side ports.

Result PLUG IN UNIT

For circuit unitization, faster final assembly, stock reduction and ease of equipment maintenance.

VECTOR ELECTRONIC COMPANY
3352 San Fernando Road, Los Angeles 65, Calif.
Telephone CL 7-6237

Incoming IRE President D. G. Fink

TV to Europe via the moon?

Use of the moon as a radio relay station is a possibility in the near future. U. S. Naval Research Laboratory have already bounced signals off the moon.

Audio and TV modulated carriers, aimed at the moon, could be made to bounce off to the U. K. and Europe. This would be possible for about four hours in 24—period that the moon is optically in sight of both North America and Europe.

First U. S. experiments were with ten microsecond pulses at 200 mcs with one megawatt power. To get an antenna large enough a parabolic-shaped hole, 250 feet in diameter, was dug out of the earth.

Early experiments gave a value for the distance from the earth to the moon that differed from the distance calculated optically.

Experiments this year were at 3,000 mcs. The two microsecond wide pulse did the round trip of nearly 500,000 miles in some two and a half seconds.

Industry issue

How has the Canadian electronics industry fared during the past year? What are the prospects for 1958?

To get an answer to these important questions Canadian Electronics Engineering contacted manufacturers throughout the industry. The result is the most comprehensive report on the industry ever made to Canadians engaged in electronics and allied fields.

Industry Review and Forecast issue of CEE will appear in January. The issue will also feature an important article by Dr. M. P. Bachynski of RCA Victor describing research work being done on radio transmission over mountains.

S. F. Love, Radio Valve Company, and chairman Preben Gomard

Electronics is the fastest growing industry in the U.S. West

Tremendous growth of the electronics industry in the West Coast areas of the United States is still going on, says Ira J. Karr of the Hoffman Electronics Corporation. Mr. Kaar was speaking on "Electronics in the West" at the Radio Fall Meeting in Toronto. The meeting was sponsored by the Electronic Industries Association, with RETMA of Canada and the IRE Professional Groups.

Engineers rush to the States

More than 3,000 engineers left Canada between 1951 and 1956, a figure equivalent to almost one third of the graduating classes of that period and ten percent of all the professional engineers in Canada. Eight hundred other scientists also left Canada in those years.

Figures are given by the Technical Service Council. Dr. Robert A. Bryce, chairman, comments: "The largest missile centre in the western world could be set up with the Canadian scientists who have emigrated to the United States recently.

"Many of these men, trained at great expense to the taxpayers, are research workers with postgraduate degrees. They leave Canada because they cannot get positions in their field of interest."

Mr. Kaar received this year's plaque for his many "contributions to the broadcast and television receiver industry."

In his speech Mr. Kaar said the explosive period in the West was from 1950 to 1954 when business doubled every year.

Even today, the era of inflationary depression, electronics in the West was still growing. In late 1956 the area accounted for 15% of all the electronic firms in the country, provided 18% of the employment of the industry and 16% of the sales.

In the Engineering Department Session C. J. Hirsch, Hazeltine Corporation, described the problems of sharing programs in Europe with different languages and transmission systems. There was also a session on Quality Improvement and Reliability.

Other sessions were on radio and television and electron devices. Preben Gomard, Canadian Electronics Company, Hamilton, presided at one session when S. F. Love, Radio Valve Company Ltd., gave a paper on "Minimizing the effect of cut-off in TV vertical oscillators."

COMING EVENTS FOR YOUR DIARY

December

9-13 Eastern Joint Computer Conference. Washington, D.C.

January, 1958

27-28 AIEE - IRE Scintillation Counters Conference. Washington, D.C.

February

2-7 AIEE Winter General Meeting. New York.

20-21 AIEE-IRE-U of P Transistor & Solid State Circuits Conference. Philadelphia.

March

17-21 EJC Nuclear Congress. Chicago.

24-27 Radio Engineering Show & IRE National Convention. New York.